CANADA-SASKATCHEWAN
SOUTH SASKATCHEWAN RIVER BASIN STUDY

TECHNICAL APPENDIX I

ISSUES DOCUMENTATION

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1.0 INTRODUCTION

1.1 THE SOUTH SASKATCHEWAN RIVER BASIN STUDY

The results of the Canada-Saskatchewan South Saskatchewan River Basin Study (SSRBS) are documented in a series of reports. The final report provides a summary of the findings in a form suitable for use by the general public. The final report is supported by seven technical appendices: Issues Documentation, Water Quantity, Water Quality, Water Use, Environment, Water Management and The Framework Plan. The technical appendices provide sufficient detail for use by water management professionals. The technical appendices are based on detailed studies reported in more than 60 technical reports prepared for the basin study and various reports on the study area prepared for other purposes. A complete list of the technical reports is included in Appendix A of this report.

This technical appendix, "ISSUES DOCUMENTATION", documents the current and emerging issues related to the water resources of the Saskatchewan portion of the South Saskatchewan River Basin. In order to provide some context for this report, sections have been included on the background to the study and on the water resources of the study area.

1.2 STUDY BACKGROUND

The South Saskatchewan River is the most reliable supply of good quality water in the southern half of Saskatchewan. It contributes significantly to the social and economic well-being of the people of the region. During the early 1980s, several events led to increasing concern about the ability of the river to meet future needs.

The water resources of the South Saskatchewan River are intensively used by Alberta. Alberta irrigates more than a half million hectares of land in its portion of the basin. During the mid-1980s, Alberta completed a planning study which identified a range of future development options. Several of the options provided for significant expansion of irrigation which would further reduce the amount of water passed to Saskatchewan.

Since its joint development by the federal and provincial governments more than 20 years ago, Lake Diefenbaker has become a focus for development in the Saskatchewan portion of the basin. This multi-purpose reservoir supports irrigation, hydro-electric energy generation, recreation, industrial and municipal water supply. In Saskatchewan, plans were also laid during the 1980s for further development based on the water resources of the South Saskatchewan River, particularly Lake Diefenbaker.

These plans included significant irrigation development. At the same time, proposals were made to further develop the recreation potential of the reservoir. Such developments would place additional demands on the water resources of the South Saskatchewan River.

While further development was being considered for the South Saskatchewan River Basin in both Alberta and Saskatchewan, there were several drought years in the 1980s. The droughts led to increased demand for water while the supply was reduced. In Saskatchewan, this caused problems for most water uses. There was concern regarding the ability of Lake Diefenbaker to support continued development. Weed growth at the upstream end of Lake Diefenbaker also led to concerns that the high quality water in Lake Diefenbaker was at risk.

The possibility of increased development, coupled with a reduced supply, led to greater concern about diverting water from the basin. Prior to the study, there had been a number of options identified for increased diversion of water from the South Saskatchewan River. However, when such diversions were identified, existing users expressed concern about the possible impacts. There was a clear need to determine the importance of the water in the basin to existing and future users.

The Canada-Saskatchewan South Saskatchewan River Basin Study was undertaken to provide information to guide water management. It will help ensure that the water resources of the basin can meet the needs of existing and future users.

1.2.1 The Study Agreement

On May 16, 1986, Federal Environment Minister Tom McMillan and Minister Responsible for SaskWater, Eric Berntson, signed the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement. The agreement set aside 1.6 million dollars for the study with expenses shared equally by SaskWater and Environment Canada. The agreement established policies and procedures for a study of the Saskatchewan portion of the South Saskatchewan River Basin.

The Agreement identified three objectives for the study:

(a) "document the current and emerging water and related issues in the South Saskatchewan River Basin in Saskatchewan;

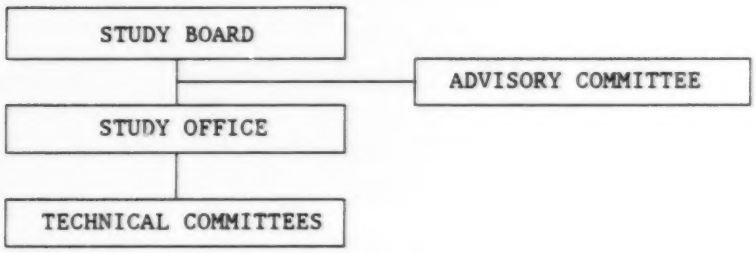
(b) "carry out an assessment of the water and related resources of the South Saskatchewan River Basin, and their current and future use;

(c) "develop a framework plan for the conservation and management of the water in the South Saskatchewan River Basin in Saskatchewan which allows for the evaluation of water resource projects."

1.2.2 Study Organization

The South Saskatchewan River Basin Study Board was responsible for the completion of the study. The board had one representative from each of the two sponsoring agencies: Environment Canada and SaskWater.

STUDY ORGANIZATION



An advisory committee provided policy information to the study board. Senior officials, representing agencies with water management responsibilities or interests in the basin, made up the advisory committee.

The study board set up the South Saskatchewan River Basin Study Office and staffed it with a director, assistant director and secretary. The director was responsible to the study board for the day-to-day administration of the study.

Technical committees assisted the study office. Representatives for the committees were drawn from agencies with responsibilities for water management. The agencies included federal and provincial departments, crown corporations and municipalities.

The technical committees provided the study office with expert advice on water quantity, water quality, water use and public involvement. A management strategies technical committee was responsible for drawing together the information produced by the other technical committees and identifying management options.

The technical committees also helped develop terms of reference for work carried out by consultants. More than 20 different consultants participated in the study. The consultants played a role in compiling the basic information needed to carry out the study.

PARTICIPATING AGENCIES

Environment Canada
SaskWater

Agriculture Canada
- Agri-Food Development Branch
- Prairie Farm Rehabilitation Administration

Western Economic Diversification

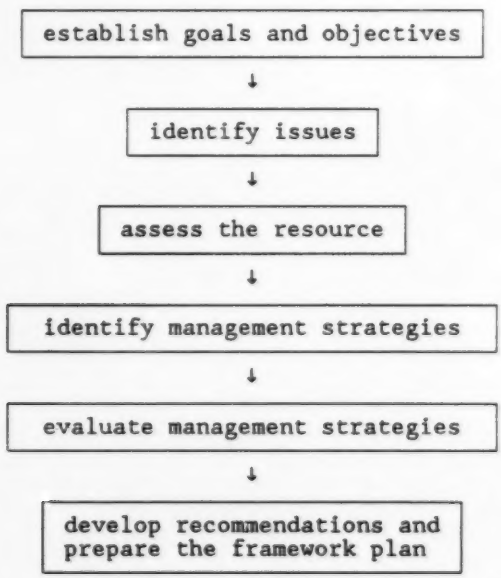
Saskatchewan Environment and Public Safety
Saskatchewan Parks and Renewable Resources
Saskatchewan Culture, Multiculturalism and Recreation
Saskatchewan Rural Development
Saskatchewan Agriculture and Food

SaskPower
City of Saskatoon
Meewasin Valley Authority

1.2.3 Planning Process

Early in the study, the study board defined the planning process and eight planning principles. These principles guided the study.

THE PLANNING PROCESS



PLANNING PRINCIPLES

THE WISE AND EFFICIENT MANAGEMENT AND USE OF WATER SHOULD BE PROMOTED THROUGH ALL POSSIBLE MEANS.

THE ECOLOGICAL INTEGRITY OF WATER RESOURCE SYSTEMS SHOULD BE MAINTAINED.

PUBLIC INVOLVEMENT IS ESSENTIAL FOR THE STUDY TO ACHIEVE ITS OBJECTIVES.

ALL WATER USES THAT HAVE SOCIAL, ECONOMIC OR ENVIRONMENTAL VALUE SHOULD BE CONSIDERED.

DOMESTIC WATER USE SHOULD BE THE HIGHEST PRIORITY AMONG ALL USES.

THE WATER RESOURCES OF THE BASIN SHOULD BE MANAGED FOR THE BENEFIT OF ALL PEOPLE IN THE PROVINCE.

WATER RESOURCES SHOULD BE DEVELOPED AND MANAGED CONSISTENT WITH THE CONCEPT OF SUSTAINABLE DEVELOPMENT.

INTERPROVINCIAL SHARING OF WATER IS BASED ON THE MASTER AGREEMENT ON APPORTIONMENT.

The planning process included the use of a base year as the reference point for the analysis of future conditions. The base year for the South Saskatchewan River Basin Study was 1986 -- the year the study began.

There were three separate planning exercises undertaken. They related to three different time horizons. The short-term planning exercise focused on the year 2000 and dealt with water management issues in the basin. The long-term planning exercise looked at the year 2020 and established a range of development options. The third and final planning exercise was the system-limit. It helped put the long-term planning exercise in perspective by identifying the development limits of the basin.

There are three main components to the study area: Mainstem South Saskatchewan River, Saskatoon Southeast Water Supply (SSEWS) system and Swift Current Creek. Although water management in these components is interrelated, the interrelationships are minor. Therefore most aspects or the study considered each component separately. The Mainstem includes the South Saskatchewan River from the Alberta border to the confluence with the North Saskatchewan at the downstream end of the study area. Lake Diefenbaker is included in the Mainstem component. The effects of actions on this mainstem area on the Saskatchewan River downstream of the study are were also considered in the mainstem section of the report. For this study, the SSEWS system was considered to include all of the works downstream of the East Side Pump Station near Gardiner Dam on Lake Diefenbaker. The Swift Current Creek Basin includes the Rushlake Creek basin.

1.3 SYSTEM DESCRIPTION

The following is a brief introduction to the water resources of the study area. More details are provided in the body of this report and in the other reports of this series.

1.3.1 Mainstem

The South Saskatchewan River rises in southern Alberta where it receives runoff from about 120 000 km² of drainage area. A portion of this drainage basin is located on the eastern slopes of the Rocky Mountains and foothills. This portion is a highly productive runoff area, producing virtually all of the flow received at the Alberta - Saskatchewan border where the average annual natural flow is 9 200 000 dam³. This natural flow has ranged from lows of about 4 800 000 dam³ in dry years to 16 000 000 dam³ in wet years. On average, about two-thirds of the runoff occurs in the May to August period and less than 10 percent occurs in the December to March period.

In Alberta the water is used for irrigation, municipal, industrial, hydro-electric, fish, wildlife and recreation uses. On average, the flow is reduced by about 1 900 000 dam³ per year, with irrigation taking about 95 percent of the water.

In Saskatchewan the river flows through a region of very low runoff. On average, the local runoff augments the natural flow by about 2 percent with half of this local flow originating in Swift Current Creek. Figure 1 shows the drainage area in Saskatchewan.

The largest water uses in Saskatchewan are centred around Lake Diefenbaker and the city of Saskatoon. Total water consumption averages about 500 000 dam³ per year. Evaporation from Lake Diefenbaker accounts for about half of this total, irrigation is the second largest user and municipal and industrial users take a relatively small portion of the flow. Although less than 10 percent of the water is consumed, the remaining water is used for important instream purposes, including hydro-electric generation, recreation and fish and wildlife.

Downstream of the study area the South Saskatchewan River joins the North Saskatchewan River and their combined flow continues east in the Saskatchewan River. Within Saskatchewan the flow is used to generate electric energy at the Nipawin and E. B. Campbell Power Stations. Downstream of the Saskatchewan - Manitoba border, the Grand Rapids Power Station uses the river before the water discharges to Lake Winnipeg. At Lake Winnipeg the water joins other flows from the south and east as it flows down the Nelson River to Hudson Bay. Along the Nelson River, there are additional power stations. In addition to the power stations the rivers downstream of the study area serve as local transportation routes, provide habitat for fish and wildlife and serve the water supply needs of several communities.

The quality of the water in the mainstem is very good, meeting the requirements of all of the existing and projected users. Upstream of Lake Diefenbaker the quality varies from season to season with the rate of flow but in the lake the seasonal variations are mixed, producing a very uniform quality downstream. Within the study area the greatest pollution threat arises from municipal and industrial effluents in the Saskatoon area where effluent treatment requirements are regularly under review.

1.3.2 SSEWS System

The SSEWS system is a manmade water delivery system which draws water from Lake Diefenbaker and delivers it to an area northeast of the lake as far as Lanigan as shown on Figure 2. The major uses of the water are irrigation, industries, municipalities, recreation and wildlife. The largest irrigation project is the South Saskatchewan River Irrigation District which serves over 16 000 ha. Potash mines are the main industrial users.

The quality of the water at the upstream end of this system is equal to the mainstem, since it is drawn from Lake Diefenbaker. As the water moves downstream in the system, local surface and ground water inflows of less desirable quality are added and evaporation concentrates impurities resulting in a lower quality of water. The quality is satisfactory for the uses made of it, but is less than ideal.

1.3.3 Swift Current Creek

Swift Current Creek is the largest tributary to the mainstem in Saskatchewan. This creek drains a portion of the Cypress Hills as shown on Figure 3. The average natural flow is about 80 000 dam³ and the annual flow ranges from about 20 000 dam³ to 265 000 dam³.

Swift Current Creek water is used for irrigation and as a source of supply for municipal water at the city of Swift Current and the village of Herbert. The irrigation and municipal systems rely on Duncairn Reservoir for flow regulation to overcome natural periods of low flow. The water supply system from Swift Current Creek extends to areas of the neighbouring Rushlake Creek Basin. In addition to the consumptive water uses, the water of this creek is used for recreation, fish and wildlife. Although the quality of the water in this area is not as good as that in the mainstem, it has been satisfactory for the current uses.

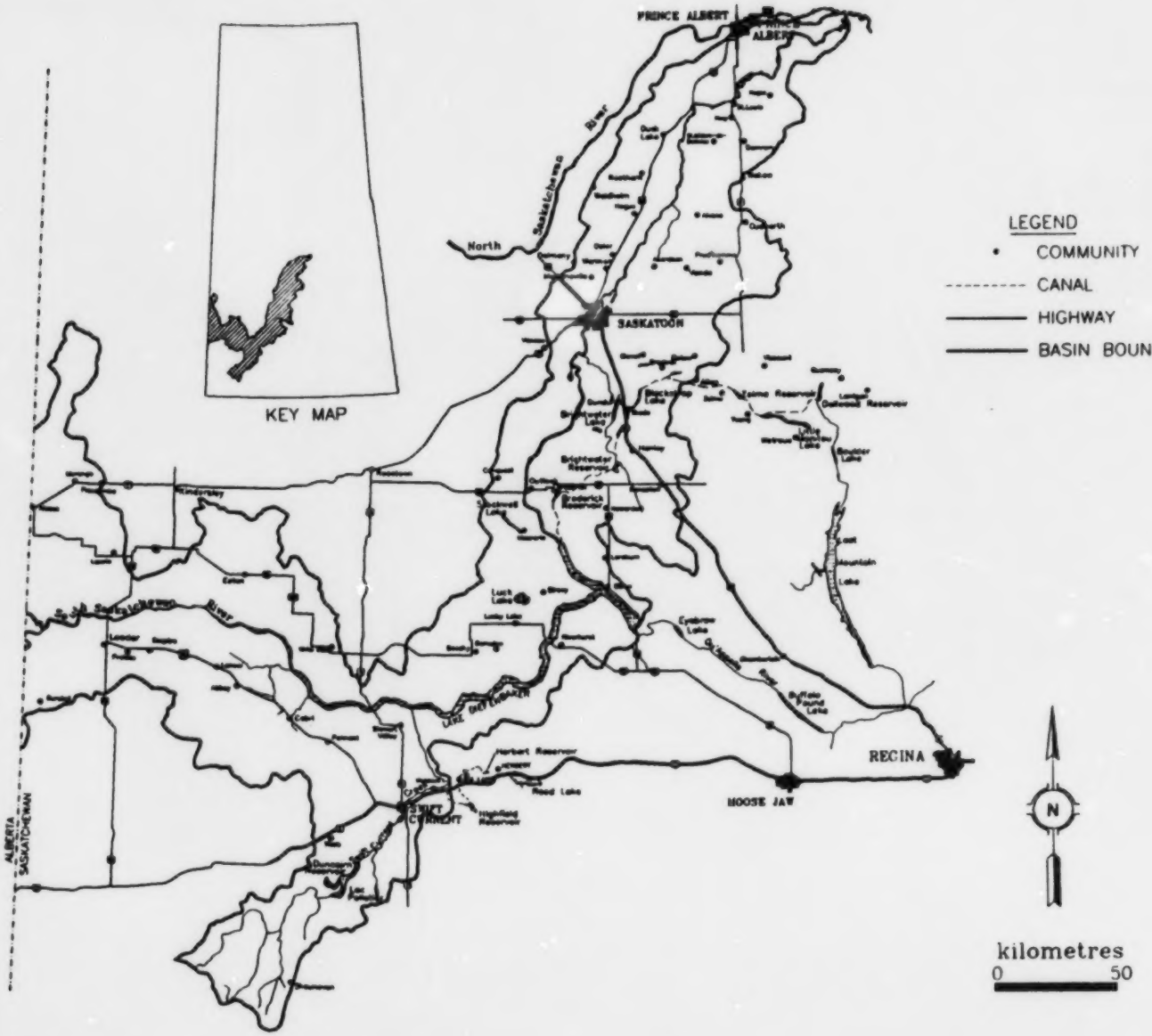


FIGURE 1 THE STUDY AREA

FIGURE 2 **SASKATOON SOUTHEAST WATER SUPPLY SYSTEM**

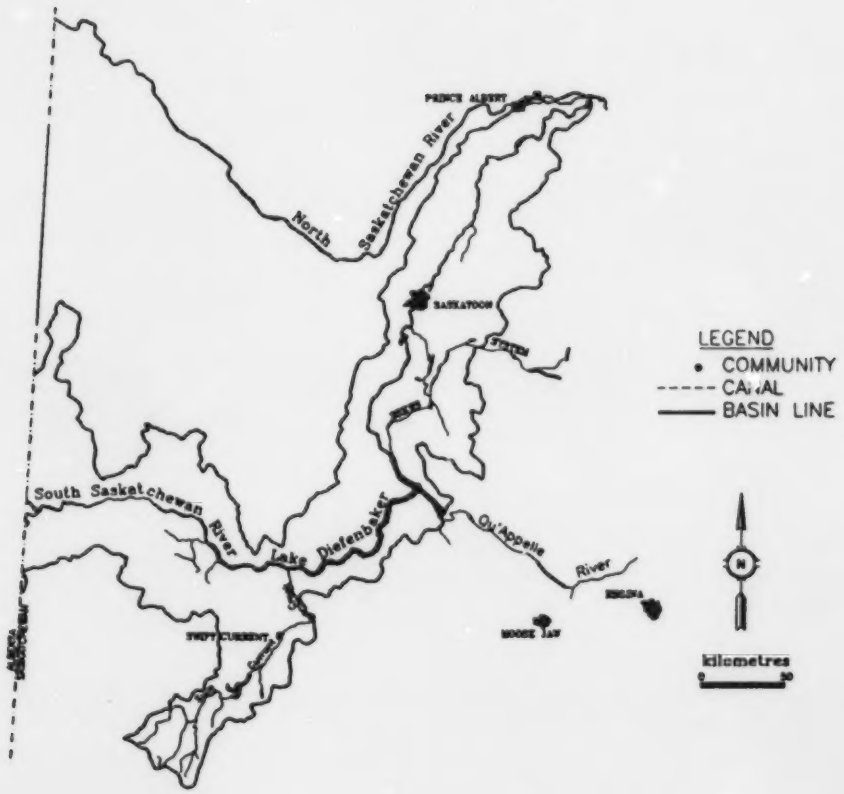
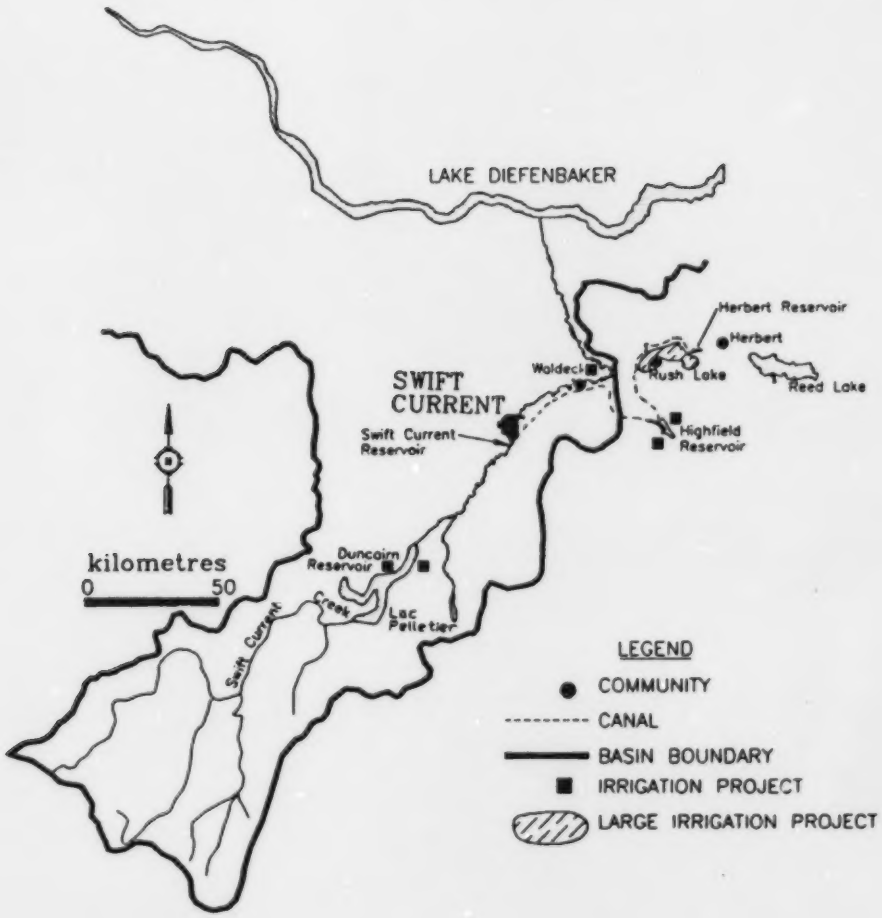


FIGURE 3 **SWIFT CURRENT CREEK**



2.0 ISSUES DOCUMENTATION

2.1 BASIN-WIDE ISSUES

There are a number of issues which occur throughout the basin or cover several subregions. For example, some aspects of water quality, water allocation and flow regulation are of general concern. These issues are discussed in this subsection. Issues which occur in specific subregions are discussed in the following subsections.

2.1.1 Water Quality

High quality water must be maintained in the South Saskatchewan River system. Sources of good quality water in southern Saskatchewan are scarce. This particular system provides drinking water for more than 40 percent of the province's population and is a major source of water for industry, irrigation and recreation. It is not surprising that many of the basin-wide issues relate to water quality.

An issue that is common to all water quality concerns is the need for a good database.

Twelve groups (city of Moose Jaw, 1987; city of Regina, 1987; John Smith Indian Band, 1987; Saskatoon Canoe Club, 1987; R. M. of Corman Park, letter dated July 29, 1987; city of Saskatoon, 1987; Resort Village of Thode, letter dated July 17, 1987; Cabri Regional Park Board, letter dated October 13, 1987; Chesterfield Water Users Association, 1987; city of Swift Current, 1987; Swift Current Wildlife Federation, 1987; Lac Pelletier Regional Park Board, letter dated October 13, 1987 and the Water Quality Technical Committee) expressed concern about water quality in the basin. There are three major categories of water quality issues of basin-wide concern: eutrophication, salinization, and contaminants.

2.1.1.1 Eutrophication. Eutrophication is a process whereby a body of water becomes rich in plant nutrients, such as phosphorus and nitrogen. While this is often a natural process, man has the capacity to dramatically increase the rate of eutrophication. Man can influence the rate of eutrophication in a variety of ways. Increases in the rate of nutrient loading from non-point or diffuse sources can arise through land management practices which increase the rate of soil erosion or enrich the nutrient loading in other ways. Point sources of nutrients include the effluent from 15 municipalities which release effluent to the South Saskatchewan River and its tributaries (SSRBS Technical Report E.6). Nutrient loading also originates from both point and non-point sources in Alberta.

Eutrophication

Increases in plant nutrients can lead to excessive plant growth in the form of both algae and aquatic weeds which can lead to changes in the fish species composition and reductions in the aesthetic appeal of the water; both of which can inhibit recreation. Perhaps more importantly, algal blooms can lead to taste and odour problems which cannot be removed through standard municipal water treatment processes. This can result in the need for expensive treatment processes, such as those currently in use by the Buffalo Pound Filtration Plant which treats the water supply for the cities of Regina and Moose Jaw.

The addition of plant nutrients and resulting eutrophication were identified as an issue (SaskWater and Environment Canada, 1986; Water Quality Technical Committee, Summary Notes, August 27, 1986). Several portions of the South Saskatchewan River system are already showing signs of becoming eutrophic. A recent study by Saskatchewan Environment and Public Safety and Environment Canada shows that the upstream end of Lake Diefenbaker is becoming slightly eutrophic. Swift Current Creek and the SSEWS system have high concentrations of nutrients which are resulting in eutrophic conditions in lakes and reservoirs. The reach of the South Saskatchewan River downstream of the city of Saskatoon has increased weed growth which has been attributed to the nutrient contribution from city effluent.

Controlling eutrophication will require reductions in the nutrient contributions from both point and non-point sources. Loading from some non-point sources can be reduced through changes in agricultural and watershed management practices. Reduction of loading from point or municipal sources requires considerable capital investment and time to implement.

2.1.1.2 Salinization. High concentrations of dissolved minerals, or salinization (i.e. major ions such as calcium, magnesium, sodium, bicarbonate, sulphate, and chloride) in surface and ground water are common in arid regions. Saskatchewan waters are commonly high in salts. High rates of evaporation and ground water discharge can naturally concentrate minerals in surface water. Agricultural practices can also significantly increase the mineral loadings to surface waters. Irrigation return flow, particularly from tile drained fields, usually has high concentrations of minerals.

Salinity

Salinity

The presence of high concentrations of minerals may have widespread implications for a variety of water users. Increased salt can reduce the acceptability of the water for use in irrigation on certain soils and, if very high, can eliminate irrigation entirely. High mineral concentrations can also render water unsuitable for municipal, industrial and other uses or result in expensive treatment requirements.

Within the South Saskatchewan River Basin, salinity has been identified as a potential problem by several groups including the Water Quality Technical Committee. Two factors contributing to increased salinity are irrigation return flows and, through increased evaporation, reservoirs. Both Alberta and Saskatchewan have plans to increase the amount of irrigated land within the South Saskatchewan River Basin. In addition, Alberta is in the process of developing the Oldman Dam, which will create a new reservoir on the system. A preliminary report on water quality in the basin (SSRBS Technical Report D.3) suggests that the concentrations of chloride and sodium are showing trends toward increasing concentration at certain locations. At present the levels are well below those which impair use.

Water Quality Objectives

The Prairie Provinces Water Board which monitors interprovincial water issues is developing water quality indicators for these parameters at the Alberta/Saskatchewan and Saskatchewan/Manitoba borders.

In addition to the mainstem of the South Saskatchewan River, high mineral concentrations are of concern in the Swift Current Creek Basin and SSEWS system. These concerns are discussed further in the appropriate sub-basin sections.

2.1.1.3 **Contaminants.** Contaminants are generally comprised of two categories of substances: heavy metals (e.g. mercury, cadmium) and organic substances (e.g. pesticides, wood preservatives). Contaminants are a concern throughout the basin. This concern stems from the fact that they can impair water uses at very low concentrations. For example, fish with concentrations of mercury greater than one part per million are not recommended for consumption (Saskatchewan Parks and Renewable Resources, 1987).

Contaminants

Heavy metals can be derived from natural sources, such as soils and rocks, or from industrial sources, either within Saskatchewan or upstream in Alberta. Saskatchewan has eliminated most of the industrial sources of metals, particularly mercury. As a result, the concentration of mercury in fish has been reduced, but is still sufficient to result in restrictions on recommended fish consumption in the basin. The water quality monitoring programs do a fairly comprehensive job of measuring metals. However, while there is information about the distribution of heavy metals in the river system, less is known about their impact on the environment.

Heavy Metals

Unlike metals, most organic contaminants originate from anthropogenic sources. Despite the fact that organic contaminants, in particular pesticides, are used throughout the basin, monitoring programs do not include all of the pesticides commonly used by the agricultural industry (SSRBS Technical Report D.4). Furthermore, most monitoring programs have only recently been expanded to include the more commonly used compounds. As a result, the issue surrounding organic contaminants stems both from a lack of information as to their spatial and temporal distribution within the basin's waters and their environmental significance.

Organics

The main issue regarding contaminants is the lack of information on their environmental significance. This issue is common to water management in all areas and is not unique to the South Saskatchewan River Basin. The resolution of this issue is being pursued through provincial and national environmental research and management programs. Resolution of this issue is beyond the scope of this basin study.

2.1.2 Flooding

Flooding is a natural occurrence in all river systems. As such, the issue is not flooding, but rather how to deal with it.

Flooding presents a risk of property damage and loss of life. The impacts of flooding in rural areas tend to be spread over a diverse area so that the opportunity for mitigation is limited. In urban areas impacts tend to be more concentrated. The risk of flooding throughout the South Saskatchewan River Basin has been altered through the creation of numerous dams and reservoirs. The only one of significance for flood control on the South Saskatchewan River mainstem in Saskatchewan is Lake Diefenbaker.

Despite the presence of Lake Diefenbaker, flooding remains an issue in the basin. Lake Diefenbaker has reduced the threat of flooding by eliminating the frequent spring and summer floods that used to occur and reducing the level of flooding in the infrequent extreme floods.

Because there has not been a serious flood on the South Saskatchewan River system since the construction of Gardiner Dam, the municipalities located adjacent to the river downstream of the dam have developed a false sense of security regarding flooding. Lake Diefenbaker was designed as a multi-purpose project. It was not designed, nor is it operated solely as a flood control project. While SaskWater, the agency responsible for operating the dam, will do everything possible to use Lake Diefenbaker to reduce the impact of a serious flood, flooding simply cannot be eliminated by this project. In the event of a serious flood, the project can reduce the damages but not eliminate them entirely.

Lake Diefenbaker

The impacts of flooding can be reduced in two ways. In the short-term the impacts of flooding can, and are to a great extent, ameliorated through flood forecasting. Flood forecasting reduces flooding in two ways. The forecasts provide a basis for appropriate adjustment in the operation to take advantage of the storage capacity available to attenuate peak flows. Forecasting also provides lead time for landowners and municipalities adjacent to the river to take appropriate action. Such response reduces the risks of property damage and loss of life. Because recent years have had low runoff, none of the communities in the basin expressed concern regarding the adequacy of the provincial flood forecasting program. Maintaining flood awareness, forecasting and flood warning systems up to date are difficult issues to emphasize during low runoff years but they should not be overlooked.

Flood Forecasting

From the long-term perspective, an integrated approach involving both structural and non-structural methods of reducing the risks associated with flooding is the best approach. Such an approach is promoted through the federal/provincial Flood Damage Reduction Program (FDRP). This program stresses the use of zoning to reduce the presence of structures which could be prone to flood damage in the flood hazard area and thus reduce the risks of flood damage in urban areas. The program also endorses the use of structures such as dams and dikes to reduce risks. The initial phases of the program which involve identifying the flood hazard area have been completed for the cities of Swift Current and Saskatoon but the final phase of designating the floodway has not been completed. This final phase will be completed when the cities implement land use controls necessary to reduce the risk of flood damage.

FDRP

2.1.3 Flow Regulation

The South Saskatchewan River is a relatively heavily developed river system. There are numerous dams on the river and its tributaries in Alberta. Through operation of these dams and reservoirs, water managers in Alberta can control the flow of the river to a certain extent. These projects permit water users in Alberta to store the high flows of spring and summer so that they can be used for municipal, industrial, agricultural, recreation and other uses. This flow regulation in Alberta results in changes to the flow regime entering Saskatchewan.

There is a perception that Alberta might eventually use so much water that there will be inadequate water for Saskatchewan needs. Prior to 1969 this was a major issue, not only to Saskatchewan, but to Canada, Alberta and Manitoba as well. Development opportunities which would take advantage of the water resource were known to exist across the prairie region but no jurisdiction was able to efficiently plan for development since no clear definition of each jurisdiction's right to the resource existed. In 1969, the governments of Canada and the three Prairie Provinces reached an agreement on an equitable formula for sharing this common water resource. The Master Agreement on Apportionment sets out the limits on flow regulation that each jurisdiction may make. A copy of the text of the Master Agreement on Apportionment is contained in Appendix B. In general, Alberta must permit at least one-half of the natural flow in each calendar year to reach Saskatchewan. In recognition of certain developments in Alberta at the time of the Agreement, a special provision provides for Alberta to divert 2 590 000 dam^3 of water even though that would be more than one-half of the flow but Alberta is not permitted to use more than half the flow if such use would reduce the flow into Saskatchewan to less than 42.5 cubic metres per second. Saskatchewan and Manitoba similarly, equally share the water that comes from Alberta plus water that arises in Saskatchewan. With the Master Agreement in place, each province can now plan for developments within its borders. Under this Agreement, Saskatchewan is assured of an equitable share of the water resource and Saskatchewan is obliged to pass an equitable share to Manitoba. The South Saskatchewan River Basin Study has taken the Master Agreement as the limit on flow regulation options that are worthy of study. That is, only options that fit the terms of the apportionment formula will be considered.

Master Agreement on Apportionment

The Province of Alberta recently completed a study of the South Saskatchewan River Basin in Alberta. In that study the probable impact on flows at various points of various regulation opportunities was studied. The Alberta study included the provisions of the Master Agreement as a limit on potential flow regulation and development. The flows that would result at the Alberta/Saskatchewan border under a variety of potential alternative future scenarios are available from this study and can be built into the modelling studies of the Saskatchewan portion of the basin. The most extreme scenario of upstream flow regulation that would be worth considering would be the assumption that Alberta might in the long-term develop the capability to divert all of its share of the flow under the formula specified by the Master Agreement.

Alberta's South Saskatchewan River Basin Planning Program

The second aspect of flow regulation is the control on the flows that is possible using works within Saskatchewan. There is only one major dam and reservoir on the South Saskatchewan River that regulates flows. Lake Diefenbaker has sufficient usable or live storage volume and control works that it has a very significant impact on the flow. The lake has live storage approximately equal to one-half the average annual flow of the river. This is sufficient capacity to make very large changes to the daily, monthly and seasonal flow patterns but is only sufficient to modestly change the annual flow volumes. While the storage changes the flow pattern, it does not change the total flow. The lake does result in some overall reduction in the total flow as a result of evaporative losses and uses such as irrigation which have developed because of the presence of the lake.

Lake Diefenbaker

The regulation of flows and water levels at Lake Diefenbaker affects all users of this multi-purpose project. The objective of SaskWater, the agency charged with the operation of this and all other major provincial water resource projects, attempts to maximize the economic and social benefits of the project by taking all user interests into account in planning the operation of the project. The operation has achieved some very large benefits to most users and the operators are constantly striving to obtain a better understanding of the potential uses in order to continue to improve on the overall benefits. Each user of the project and of the river system would prefer a particular flow and water level regulation regime that is best suited to that particular use. The operators of the system were strong advocates of this basin study in anticipation that the results will permit continued improvement in the efficiency of operation. The following paragraphs briefly summarize the issues as perceived from various user points of view with a brief indication of the conflicts that arise.

Irrigation

Irrigation projects that use the lake as a water source would prefer to have the lake operated at a high and stable level throughout the irrigation season. This would reduce the difference in elevation between the lake and the irrigated area and, therefore, the pumping costs. It would also improve the convenience of pumping from the lake and reduce the cost of pumping facilities. A varying level requires higher cost intake works in order to accommodate the variations. In spite of information that showed the range of potential water level variation to be expected, some of the early irrigation projects were designed and built with inadequate allowance for the range of potential levels. Most of these have been improved and all of the recent projects have been built to accommodate the variation in water levels. The irrigation season extends from May to September. In order for the lake to be high throughout this season the storage volume would not be available to capture the main runoff which occurs in May to July and there would be limited ability to control floods that might result from heavy rains in the Alberta headwaters throughout the summer.

Irrigation projects along the river downstream of the project would prefer that the operation provided stable flows in the river so their intakes would provide a reliable water supply.

Recreation

Recreation uses around the lake favour stable levels. As with irrigation, stable levels limit the opportunity to use the full range of operating levels which help meet the needs of other users. In the early development of the project the wide ranging water levels were anticipated and most of the recreation facilities have been designed to accommodate the variations. Shoreline developments have been controlled through land use regulations to prevent developments that would conflict with the operation of the project for all users. Although recreation has been developed to accommodate the expected water level regime, it would still be enhanced by more stable water levels.

Hydro-electric Energy Generation

Hydro-electric generation is an important use which uses flow regulation and resulting fluctuating lake levels to reduce the cost of electric energy for all the province. Electrical energy is most valuable when the demands are the highest and the alternative energy sources tend to be most expensive. The energy demands vary widely with the time of day, day of the week and season. Taking advantage of the storage capacity of Lake Diefenbaker to control the flows of the river to coincide with the peak demands can result in large economies in fuel costs at the Coteau Creek Generating Station on Lake Diefenbaker and at downstream hydro power stations on the Saskatchewan River. Since these economies accrue to virtually all of the people of the province, they are especially important.

Minimum Flow

Downstream of Lake Diefenbaker, the flows have been substantially altered by the project. The flows which were highest during the summer and very low in the winter, are now more uniform and in low runoff years this pattern has been reversed. This change in flow pattern has provided many benefits. The summer flood which often flooded the farm land on the valley floor and islands and interrupted ferry service now occurs infrequently. The minimum flow which commonly dropped below 40 m^3/s and sometimes dropped below 20 m^3/s in the winter has been artificially maintained at above 42 m^3/s since the project has been in operation. The policy of maintaining a minimum outflow was established before the project was completed and has been continued for more than 20 years. This policy of increased minimum flows has improved the ability of the river to assimilate wastes from sources like municipal effluent, and since treatment standards take into account this assimilative capacity, treatment costs have been reduced. If sufficient water were available, it might be possible to further increase the minimum flow and improve the river for effluent assimilation and other uses, but this would be at the expense of other users and the relative values would have to be considered.

Although the flow regulation strategies used to date have resulted in benefits to a variety of users, there may be opportunities for further improvements. An increase in the minimum flow limit could further enhance the benefits that have been achieved. Users, like the ferries and operators of river intakes, who find the present low flow limit inadequate could benefit along with greater benefits to those users that have already gained from enhanced low flows. Recreation users of the river, particularly in the Saskatoon reach, might also benefit.

Streamflow forecasting and flow data distribution to potential users of the information is an ongoing part of flow regulation. Keeping the forecasting procedures and information distribution up to date and constantly improving is an important ongoing issue with respect to flow regulation.

During the course of this study, quantitative data on preferred levels were assembled and are reported in the South Saskatchewan River Basin Study Report on The Framework Plan.

2.1.4 Drought

In the Saskatchewan portion of the South Saskatchewan River Basin, there is concern about two types of drought: meteorologic drought (inadequate precipitation); and, hydrologic drought (a shortage of streamflow). Since this study deals with only the lower portion of a large watershed and most of the runoff is yielded by the upper portion, the two types of drought do not always occur at the same time within the study area. Droughts of both types are large scale phenomena that are beyond management control. The relevant issue, therefore, is droughtproofing. "Droughtproofing" refers to a wide range of management strategies that may be adopted to mitigate the economic effects of drought (Marv Anderson and Associates Limited, 1983).

Meteorologic Drought

The effects of meteorologic drought are felt most strongly in the non-irrigated agricultural sector. Yields of cereal grains, oilseeds, forage crops and pasture are reduced by drought conditions. Because Saskatchewan's economy is so dependent on traditional dryland agriculture, meteorologic drought over any significant portion of the province has a major economic impact on the province. Irrigation using water from a reliable source is a droughtproofing strategy. Irrigation can also be looked upon as a droughtproofing strategy for the cattle industry, since enough forage might be reliably produced under irrigation to carry livestock producers through a period of drought without resorting to more drastic measures like reduction of herd size. Although it is beyond the terms of reference for a river basin management study, other dryland droughtproofing strategies such as snow management and improved cultural practices have potential for significant benefits.

Municipal Water Supply

Meteorologic drought also has an effect on municipalities. Municipal water use generally increases during a drought and can cause problems where the capacity of the treatment, storage and distribution systems are not adequate to keep up with the peak use. Many municipalities find it necessary to ration water in these situations (SSRBS Technical Report E.5). Drought can also reduce the quality of the raw water. Provision of a good quality water supply that can be depended upon, even in extreme droughts, is an important issue to the municipal sector. The development of an effective droughtproofing strategy will involve aspects of both supply and demand management.

Hydrologic Drought

While hydrologic drought has no effect on dryland agriculture, it is a major concern in irrigated agriculture. Low streamflow can make it difficult to obtain reliable performance from pumps and intakes. This is a problem for many private irrigators. Low reservoir levels can reduce the capacity of pumps by increasing the lift required. This has resulted in the need to ration water among farmers. During severe hydrologic drought events, yields under irrigation may be reduced because of water shortages or access difficulties. Therefore, droughtproofing is relevant to both irrigated and non-irrigated agriculture.

Irrigation

The frequency and severity of hydrologic drought in the basin may limit the long-term prospects for expansion of irrigated agriculture. At some point, irrigation development may reach a level beyond which the reliability of the water supply would make further development uneconomical.

Water Quality

Poor water quality is associated with hydrologic droughts (SSRBS Technical Report D.3). This, in turn, has negative effects on water-based recreation, the cost of municipal water treatment and the capacity of the stream to assimilate wastes. Water quality management issues take on extra importance during hydrologic drought.

Hydro-electric Energy Generation

A major impact of hydrologic drought on the economy results from the reduction in hydro-electric generation. Low streamflow means less power production. This deficit in hydro-electric generation must be made up by power generated by thermal power plants or importation from neighbouring utilities at higher cost. Although the utility managers cannot prevent the drought condition through any actions available to them, they can plan for drought possibilities and through a full knowledge of the potential for drought, mitigate some of the impact.

Hydrologic drought highlights the need for effective water management. In normal or high flow years the water manager attempts to use the resource to the best advantage. In a drought year the need to optimize the total economic and social welfare potential of the water becomes much more acute.

2.1.5 Regional Development

The role of the South Saskatchewan River as a water supply for economic growth in southern Saskatchewan is a long-term issue.

A reliable supply of acceptable quality water is a prerequisite for all types of economic growth and development to provide for the needs of new industries and to support the population growth stimulated by those industries. This is an important issue for many municipalities in the basin. Representatives of the city of Swift Current expressed concern about future water supplies required to support its continued growth. Other communities in the basin use the availability of good water to promote development opportunities.

Since the South Saskatchewan River is the only large, reliable source of good quality water in the southern part of the province, it is regarded as a regional resource. It has been used for the past 33 years to supply water to Regina, Moose Jaw and nearby communities. Population and industrial growth in this area exceeded the capacity of the local water supply and the South Saskatchewan River was the least expensive alternate for meeting the growing needs. Similar water supply limitations were preventing a region to the southeast of Saskatoon from taking full advantage of economic opportunities related to local potash and other opportunities. The SSEWS system was therefore developed to take advantage of the available, reliable and good quality supply created by Lake Diefenbaker. The water supply for a large part of the economy of southern Saskatchewan, within the basin, in the Regina and Moose Jaw region and in the Saskatoon Southeast region depends upon the South Saskatchewan River and its tributaries.

In addition to the passive role that water can play in the regional economy, water resource development can be used to actively promote regional economic growth. This approach involves the development of new economic enterprises that are heavily dependent on water. The options include irrigation, hydro-electric development and tourism. In addition to the direct outputs, these initiatives introduce some additional diversity, and thereby stability, to the regional economy.

One of the main water based economic initiatives currently under way is the irrigation development on Lake Diefenbaker. In 1986, the Governments of Saskatchewan and Canada agreed to devote $75,000,000 over a five year period to the development of new irrigation utilizing Lake Diefenbaker as a water source (Canada-Saskatchewan, 1986). The Government of Saskatchewan is also actively promoting tourism development. The nearly completed harbour, golf course and campground complex at Elbow, on the shore of Lake Diefenbaker, is a further manifestation of this active approach to be seen in the South Saskatchewan River Basin. Lake Diefenbaker has considerable unrealized recreational potential (Hilderman Witty Crosby Hanna and Associates, 1983) that can be developed within the existing water resource infrastructure. Whether it is lack of demand, lack of facilities, or some combination of the two that is holding back this type of development is an unresolved question. SaskPower brought a new hydro-electric station into production at Nipawin on the Saskatchewan River in 1986, but there are no immediate plans for further hydro-electric development.

IBEA Agreement

Recreation

The long-term issues revolve around the question of what type of development, or mix of types, will best serve to maximize the economic and social opportunities provided by the water resource. Since many opportunities tend to conflict, and since investment in infrastructure for any opportunity tends to require long-term commitment of the water resource to a use, careful evaluation of the competing potential developments will be required to ensure that decisions continue to provide the optimum long-term results as development approaches the limits of the resource.

2.1.6 Related Land Use Issues

The South Saskatchewan River Basin Study is intended to focus on water management and development. It is not intended to include a land use plan for the basin or to deal with the management of any natural resources other than water. However, there are some land resource issues that are directly related to water management and must be dealt with in order to carry out a comprehensive study of water management in the basin. These are soil and water conservation, public access to the river, shoreline development control, heritage resources, recreation, transportation, wildlife and similar issues at the interface between the water resource and land use.

A number of interest groups indicated a desire to see improved soil and water conservation in the basin (Saskatchewan Environmental Society, 1987; Birch Hills Conservation Area Authority, 1987; Resort Village of Thode, letter dated July 17, 1987; Antelope Conservation Area Authority, 1987). This concern is directly connected to water quality management and, in particular, the eutrophication issue. Both wind and water erosion of fertile topsoil carries plant

Soil Conservation

nutrients into streams and reservoirs, accelerating the eutrophication process. Land use practices which reduce the rate of soil deposition in the water are therefore of concern to water management.

Public access to the river is an issue in several parts of the basin. Lack of public access curtails recreational use of the river in some areas (Lower Saskatchewan Basin Task Force, 1979; Outlook Economic Development Council, 1987; Saskatoon Canoe Club, 1987). Public access sites that are not developed for recreational use, such as road allowances that meet the river, are sometimes heavily used and result in littering, pollution, trespassing and damage to adjacent property (Moon Lake Water Users Association, 1987).

Public Access

Shorelines tend to be a preferred location for recreation development. Experience has demonstrated that a number of different issues can arise if developments are not properly planned. Among these are poorly located subdivisions near streams and reservoirs (city of Swift Current, 1987), over-development of some shoreline areas (Resort Village of Thode, 1987), flood damage reduction (R. M. of Corman Park, letter dated July 29, 1987) and public access. The Reservoir Development Area Regulations were established to ensure that land use around designated reservoirs is appropriate. Controls on development were established for Lake Diefenbaker and the reservoirs in the SSEWS system. Other reservoirs in the basin are not controlled. The long-term potential for recreation use can be influenced by short-sighted developments and in the case of Lake Diefenbaker with its eroding shoreline, developments could be quite dangerous.

Shoreline Development

Historic and archaeologic resources adjacent to water bodies can impact on the management of the water resource. These resources can enhance recreational opportunities and aesthetic values of the water or they may limit the opportunities for development.

Heritage Resources

The planning of water resource development must recognize impacts on other infrastructure needs such as transportation. The road and rail network that serves the public can be severely disrupted by water resource developments.

Wildlife resources such as upland birds and game which are mainly dependent on land can be affected by water resource developments and must be considered in resource planning.

2.1.7 Ecosystem Health

The term ecosystem can and has been defined in a number of ways. For example, Odum (1974), defines ecosystem as any unit that involves all of the organisms in a given area interacting with the physical environment so that the flow of energy leads to clearly defined trophic structuring. Strahler and Strahler (1973) define ecosystem more simply as the total assemblage of components entering into the actions of a group of organisms. Regardless of which definition of ecosystem subscribed to, they all share one thing in common: the idea that different components of the environment are linked and that to affect one component will inevitably have effects elsewhere in the system.

Ecosystem Health

Ecosystem health is a function of both ecosystem stability and ecosystem diversity. The advance of human economic activity is seen to threaten areas containing unique natural ecosystems. For example, the filling and draining of wetlands has significantly reduced wildlife habitat as well as reducing water retention areas, thus affecting downstream flooding (Manning, 1986).

During the course of the South Saskatchewan River Basin Study concerns were expressed by a variety of groups regarding the general health of the ecosystems of the study area. These concerns were applied to many segments of the environment, including natural habitat protection, shoreline management, and wildlife and vegetation. The areas identified by those concerned were frequently related to other issues that had been recognized over the course of the study like water quality, land use, accessibility to the river, and river flows.

In general terms, concerns for the health of the ecosystems involved the interrelations among various components of the environment and the need to understand the effects of those changes beyond the immediate moment. The Meewasin Valley Authority (MVA) specifically noted its concern that humans cannot continue to exploit the resources of the study area for short-term economic benefit (Heal, 1990). The ability of the river basin to continue to support new development was often related to the idea that a healthy ecosystem is necessary for any development to be sustainable.

A common problem identified by involved groups reflected the difficulties encountered when attempts have been made to measure the health of the ecosystem. Subtle, long-term changes may be occurring that cannot be detected at the present time. For example, MVA has noted that since the construction of Gardiner Dam, the cottonwood groves in the river valley have been declining. This decline may have other implications for the ecosystem, or even indicate other, as yet unidentified, problems in the river valley environment.

It is clear that in order to effectively manage the basin a better understanding of the various components and how they interact is required. This understanding includes not only the basic components such as climate and streamflow, but also human use of the water and how this use affects other aspects of the environment.

2.2 SUBREGION ISSUES

Many of the issues in the basin are peculiar to a single sub-region. These issues are documented in the following sections.

2.2.1 Issues in Subregion 1

Subregion 1 includes the portion of the basin north of Township 38 (Figure 4). The water resources of subregion 1 are among the least intensively used of the six subregions comprising the basin (SSRBS Technical Report E.2). As a result, water resource management issues are not common. Those that do occur are related to ferry operation and the village of St. Louis.

Summer Low Flows

Since the construction of Gardiner Dam and the ensuing reduced summer flows in the downstream reach, some of the ferries operating in the downstream reach have experienced periodic difficulties. For example, in 1977 summer flows of less than 50 m^3/s caused the following problems for ferries in this subregion: Clarkboro Ferry had to raise the cables; Hague Ferry shut down for one month due to a problem with a sand bar; St. Laurent Ferry shut down for one month due to exposure of large rocks; and Fenton Ferry had to rebuild the approaches (Lower Saskatchewan Basin Task Force, 1979). Improvements made in 1977 and subsequent years have reduced the impacts of low flows but load restrictions are still sometimes necessary. These restrictions can cause inconvenience if they correspond with a season when farmers are trying to haul grain or move large equipment. These ferries also experience navigational difficulties under very high flows which occur less frequently due to Lake Diefenbaker. Ferry operation is one of the many parameters that are taken into account in long-term planning of developments and in short-term operation planning.

Water Quality

The village of St. Louis is concerned about both water quality and quantity. Being located downstream of the city of Saskatoon, the village is conscious of the potential for municipal and industrial pollution. During periods of low flow, frequent backflushing is required to keep the village's municipal intake open (village of St. Louis, 1986).

Methoxychlor

In addition to the water quality concerns of St. Louis, there have been concerns expressed regarding the use of methoxychlor to control blackflies. In the past, Saskatchewan Agriculture applied methoxychlor at five locations on the South Saskatchewan River extending from St. Louis downstream to the forks. The pesticide was applied to control blackfly populations in the hopes of reducing damages to livestock operations. Monitoring programs have revealed measurable concentrations of methoxychlor in both the sediment and biota downstream of the application sites (Muir and Yarchewski, 1986). Methoxychlor has been largely replaced in recent years by BTi, a biological control agent for blackflies.

Forks Dam

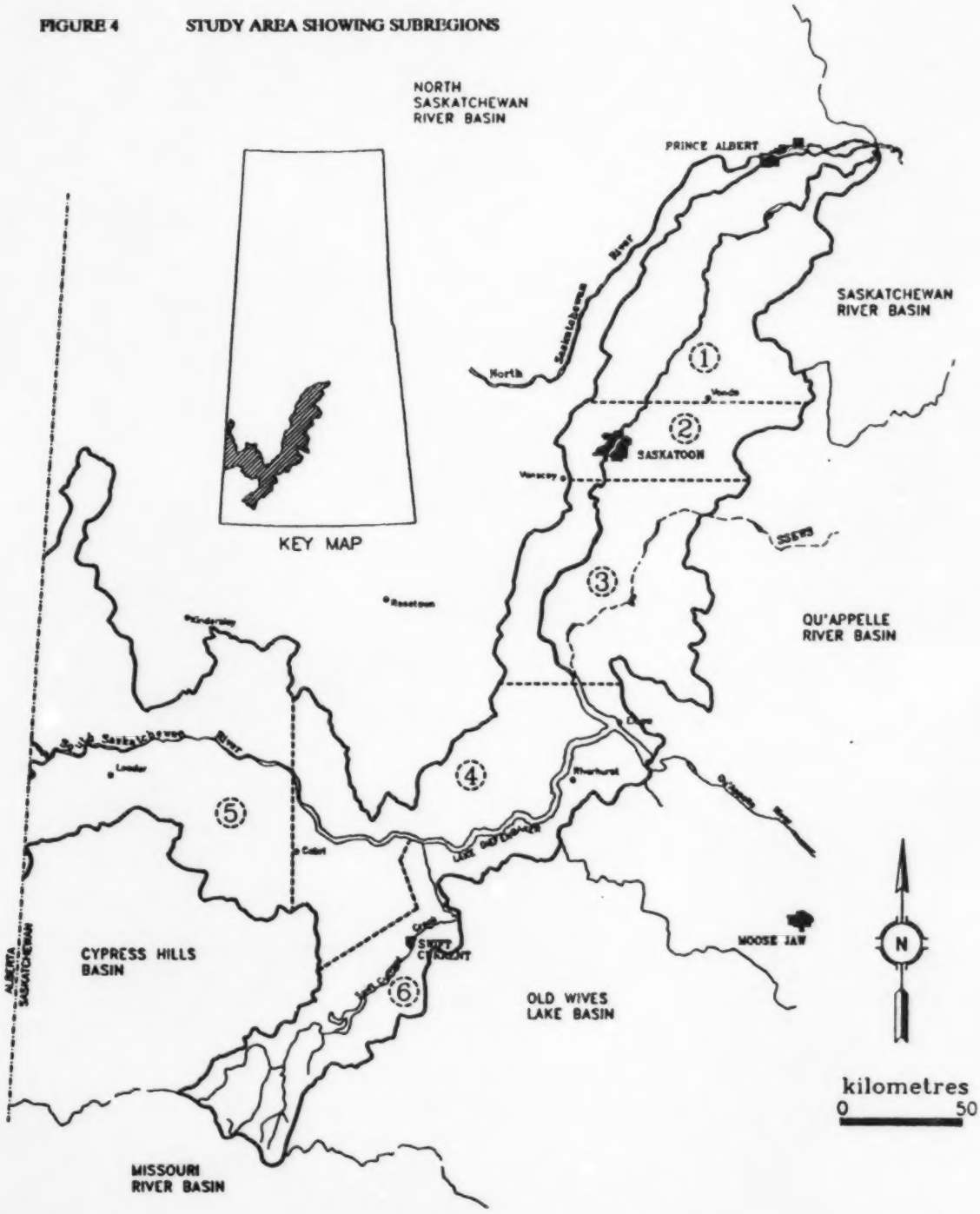
Subregion 1 would be affected by one of the few large scale developments proposed for the basin. Studied for SaskPower by Crippen Acres Ltd. (1981), the Forks Dam would be located approximately 9 km downstream of the confluence of the North and South Saskatchewan Rivers. The reservoir would flood portions of the valleys of both rivers. Flooding of the South Saskatchewan River valley would extend about 30 km upstream of the confluence. This development is presently not under active consideration by SaskPower but remains a possibility. From the perspective of the South Saskatchewan River Basin Study, the development of the Forks Dam is a long-term issue with wide-ranging implications.

2.2.2 Issues in Subregion 2

Subregion 2 which is centred on the city of Saskatoon includes all land in the basin between Townships 35-38 (Figure 4). The urban nature of this subregion results in a more intensive use of the water resources than in subregion 1. Water resource management issues include streamflow and water quality.

The South Saskatchewan River is an important aesthetic and recreational feature of the city of Saskatoon. The river extends through the city from south to north in an attractive valley setting. In recent years the provincial and civic government have invested in the development of the valley for public recreation through the Meewasin Valley Authority. The aesthetic quality of the river and its usefulness for recreational activities such as boating, are related to the flow conditions. When flows are high, the river is dangerous for most uses. When the river is low, it is less attractive and the area available for boating and water activities is limited by sandbars and shallow depth. Other recreationists make use of the sandbars for sunbathing and relaxing.

FIGURE 4 STUDY AREA SHOWING SUBREGIONS



Summer Low Flows

Since 1967 the flow of the river has been regulated by Lake Diefenbaker. Except for brief periods of flood flows when high releases were necessary to ensure the safety of the dam, there has been no problem with high water. Low flows have been a concern. Based on studies completed during construction of the dams and reviews since the project has been in operation, SaskWater, the government agency with responsibility for provincial water policy, has maintained a policy of assuring that the minimum flow at Saskatoon is 42.5 m^3/s. This flow was based on consideration of historic low flows which fell below 40 m^3/s fairly often, water supply requirements, water intakes along the river, ferry crossings, water quality and maintaining the river environment. This minimum flow has been experienced in many of the years since 1967 as the operators attempt to fill Lake Diefenbaker each summer to its optimum level for irrigation, recreation, power generation and other purposes. Some of the river users in the Saskatoon region have indicated that they would prefer higher flows. Changing the minimum flow policy would have implications for most of the other users of the river system.

Flooding

Flooding occurs in the Moon Lake area at open water flows of about 1 000 m^3/s. When ice jams occur during freeze-up, over bank flooding may occur at much lower flows. This problem was encountered several times during the early years of operation of Lake Diefenbaker. The flows are increased substantially during the winter to meet increased power demand, with flows in excess of 350 m^3/s being common. Since the first few years of operation when this problem was identified, the freeze-up operation has been carefully adjusted so that the problem is avoided. Because this flooding has been found to be sensitive to the temperature patterns during freeze-up, it will require careful operation planning every year to avoid the problem in the future.

Saskatoon Weir

In 1939, the weir in Saskatoon was built to stabilize water levels in the city. The reservoir created by the weir is small compared to the total flows of the river. Prior to construction of Lake Diefenbaker the river carried a heavy silt load. The reservoir in Saskatoon tended to trap a portion of the sediment and the pond filled in with sand. Since Gardiner Dam was built, all of the river sediment has been trapped in Lake Diefenbaker. The river at Saskatoon carries a small fraction of its original sediment load and the rate of filling at the Saskatoon weir is small. However, the sand bars that are in this reach of the river from the past are unstable and make some types of boating use difficult and dangerous.

Channel Filling

There has been some concern regarding the infilling of the river bed and floodplain within Saskatoon and its impacts on flooding (Lower Saskatchewan Basin Task Force, 1979). Discussions regarding the installation of spur dikes and ancillary facilities for the Canada Summer games demonstrate that these concerns still exist.

Designation under the FDRP and the enactment of municipal bylaws fully restricting development in the floodway have yet to occur in the city of Saskatoon.

Municipal Effluent

The city of Saskatoon is the largest population centre and the largest concentration of industrial activity in the basin. As such it is the greatest potential source of manmade water pollution. The City and Saskatchewan Environment and Public Safety have been aware of this potential and have been working over the years to ensure that an adequate level of effluent treatment is provided. Continued city and industrial growth, increasing environmental awareness, and improving knowledge of the assimilative capacity of the river have resulted in continued improvement to the level of treatment of the city effluent at considerable expense. Current plans for additional treatment will limit effluent impacts on the river for the existing flow regime and current environmental standards to acceptable levels in the short-term. In the long-term as the city grows, knowledge of the river improves and other conditions change, continued monitoring of this issue will be required.

The municipal water supply for the city of Saskatoon is drawn from the river in this reach. The continued availability for an adequate quantity and quality of water for this use must be a high priority.

Urban Runoff

In addition to sanitary sewage, urban runoff can contribute to water quality problems. Although specific problems are not presently apparent, monitoring of this potential may become an issue in the future.

Mercury

Industries outside the city of Saskatoon have also resulted in point source pollution in the past. Mercury and other contaminants were found to be increasing in the river and in the fish (Lower Saskatchewan Basin Task Force, 1979). The sources of the contaminants were brought under control. The mercury level in fish from the river has been improving and restrictions on consumption of fish from the river have been relaxed in recent years.

The concentration of human activity in the Saskatoon reach of the river will always require extra attention to the issue of pollution in this subregion.

2.2.3 Issues in Subregion 3

Subregion 3 includes the area inside the basin within Townships 27-34. It includes the reach extending from directly downstream of Gardiner Dam to the north boundary of Township 34 (Figure 4). Water quantity and quality in this reach are influenced to a large extent by the operation of the dam.

Operation of the dam can create rapid changes in flow immediately downstream. These fluctuations in flow tend to be dampened further downstream. The changing water levels that result tend to change the opportunities for water uses and activities such as recreation along the river in this reach. Water intakes must provide for a range of levels that can change in a few hours. Portable intakes must be moved in response to varying levels. Hikers can experience difficulties when flows rapidly change.

Fluctuating Flows

In addition to problems related to fluctuations in flow, both low and high flows can cause problems. Low summer flows in the river make diversions to Pike Lake, which are necessary to maintain summer lake levels and provide irrigation water for the park and nearby farms, difficult. The town of Outlook has encountered problems with its water supply intake due to the low water levels and the shifting sand bars. High flows during flood events can flood recreational facilities such as the Outlook Golf Course, disrupting use and damaging facilities. Irrigation pumps can also be damaged in flood events.

Summer Low Flows

Operation of the dam has changed the ice cover characteristics of the river downstream of the dam. The high flows released during the autumn have delayed the time of freeze-up by approximately one month. The high winter releases of relatively warm water maintain an open-water reach extending 8 to 30 km downstream throughout the winter. This open water reach has generated some concern about safety (Lower Saskatchewan Basin Task Force, 1979). The delay in the freeze-up combines with the higher autumn flows to create additional risk of ice jams and flooding. Careful operation is required to control this risk.

Winter Flows

One impact of constructing a large reservoir on a river like the South Saskatchewan which carries a large sediment load is a change in the sediment regime. Since the sediment is trapped in the reservoir, the discharge water is clear and capable of eroding the river channel downstream. This erosion can lower the tailwater on the dam causing problems with the performance of the outlet works and can affect other facilities downstream. As a result, the federal and provincial governments established a survey program to determine the stability of the riverbed downstream of the dam. This program was started during the construction of the project. To date, the monitoring has shown that erosion has been most active in the first few kilometres downstream of the dam (Yuzyk, 1987). As expected, it has changed the tailwater conditions at the dam. SaskPower has undertaken minor remedial work to offset the effects of the erosion on its power turbines. This erosion process tends to stabilize with time so monitoring can be less intense in the future but monitoring should continue. Since high flows could reactivate the erosion, monitoring will be particularly important after any major flood events.

Erosion

Subregion 3 includes the SSEWS system. This system, which originates at Lake Diefenbaker, consist of six reservoirs connected by canals (Figure 3). The system delivers an average of 80 000 dam³ water annually to a variety of users in the South Saskatchewan and Qu'Appelle River basins. Municipal water users include the towns of Hanley, Guernsey, and Lanigan and the Rural Municipality of Dundurn. Three potash mines draw water from the system. Irrigation, waterfowl and recreation projects are also served. This system exhibits some unique water resource management issues. During the drought of 1984, it became necessary to ration water on the SSEWS system. The problem resulted from an increased demand on the system coinciding with reduced pump capacity because of increased lifts. In response to these problems, SaskWater commissioned a study to examine the capacity of the system (Water Resource Consultants, 1986). In response to recommendations of the study, SaskWater has increased the pumping capacity of the East Side Pump Station by installing a fourth pump. The increased pumping capacity will eliminate shortages in the short-term, but the limitations imposed by the conveyance capacity of the canals is a long-term issue.

SSEWS

Ground water inflow, saline conditions in the soils and high evaporative losses on the SSEWS system result in declining water quality as the water moves through the system. This reduced water quality has potential implications for recreational, irrigation and municipal water users located along the system. Specific concerns have been raised by the Resort Village of Thode (letter dated, July 17, 1987) located on Blackstrap Lake regarding nutrients and algal blooms. Water quality monitoring on the system has not been as comprehensive with respect to either the range of parameters considered or the frequency of sampling as that carried out on the mainstem of the South Saskatchewan River. As a result, water quality information is not as good and it is more difficult to determine the impacts of water quality on users.

Water Quality

2.2.4 Issues in Subregion 4

Subregion 4 is centred on Lake Diefenbaker. Included in this subregion is land within Townships 13-28 and Ranges 1-18 except for the area in the Swift Current Creek Basin (Figure 4). There is substantial recreational use of the lake and its shoreline. Irrigation has been developed around the lake and further development of the irrigation potential of this area is currently under way.

Many of the issues in this subregion relate to water quantity and, in particular, the level of Lake Diefenbaker. The dams which form the lake were designed to accommodate a range of levels so that water could be stored when flows are high and released when it is needed at a later date. The upper limits of the lake level or full supply level (FSL) is at elevation

Lake Diefenbaker Operation

556.87 m. The water is never ponded above this level if it can be avoided for safety reasons. The lower limit of safe operation is at about elevation 545 m above sea level which is the bottom of the erosion protection on the face of the dams. Water levels at or near the FSL are preferred by most of the users in this reach. The recreation opportunities are best when the lake is near full. Irrigation projects benefit from reduced pumping costs due to the reduced lift. Fish spawning might be improved with more stable water levels.

Drought

The drought of 1984 highlighted the impacts of low water levels on recreation. Impacts included dry boat launches, increased distance to the water's edge, exposed mud flats and blowing sand on the beaches (Bjonback, 1986). The low water levels also had an impact on fish spawning. These negative impacts could reduce the future recreational appeal of the reservoir.

Irrigation

Irrigators also experience some negative impacts when water levels are low. In 1984, low water caused the following problems: irrigation pumps were not usable early enough in the season which resulted in restricted crop growth; portable pump units were required to support the permanent system; and increased pumping operation cost due to the additional lift. Several water users associations around Lake Diefenbaker have expressed concern about low water levels (Macrorie Water Users Association, 1987; Grainland Water Users Association, met August 11, 1987; Birsay Water Users Association, 1987).

These low water levels have not been a problem in high or average runoff years but in dry years when the lake does not recover from its winter drawdown, the low levels become an issue. The issue is a common one for water management: the sharing of potential benefits of the resource. If the reservoir were not drawn down as far each year in the winter, and if downstream flow was lowered in drought periods, the lake would be higher in the summer. This would mean, however, that less storage would be available to take advantage of normal runoff and to reduce floods in flood years. Downstream flow problems in subregions 1, 2 and 3 would be worse. The basin management planning process must take into account all of the potential benefits and hardships.

Some of these issues can be dealt with in the short-term if refinements to the operating procedures can be identified. However, if Alberta consumes an increasing percentage of the natural flow in the future, the issues revolving around lake levels would become more frequent and operation and long-term developments will have to allow for this possibility.

Water Quality

Lake Diefenbaker represents the focal point of the South Saskatchewan River in Saskatchewan. As a result, the water quality issues outlined in subsection 2.1.1 are of particular concern in this subregion. Existing and proposed irrigation development surrounding Lake Diefenbaker has raised questions regarding potential impacts of return flows on both surface and ground water quality. Concern has been expressed regarding the impacts on water quality of increased recreational use of yachts and houseboats on Lake Diefenbaker. Pollution control regulations might be required to ensure that the lake is not damaged. A joint federal/provincial study of water quality in Lake Diefenbaker indicates that areas in the western end of the lake are already becoming eutrophic. As discussed in subsection 2.1.1, all of these water quality issues have both long-and short-term aspects.

Regional Development

This subregion manifests most of the issues related to regional development discussed in the basin-wide subsection. The Lake Diefenbaker project was conceived as an economic stimulus for the region. Although many of the economic potentials of the project have been achieved, others have been slow to take hold. Irrigation development has lagged behind expectations. In order to make use of the opportunities presented by Lake Diefenbaker, the federal and provincial governments entered into an agreement on Irrigation Based Economic Development. The increased water demand associated with this irrigation development make the need for effective water resources management particularly important.

As with irrigation, recreational development around the lake has not lived up to expectations. Most communities near the lake would like to see the lake used more intensively for recreation because of the spin-off benefits (e.g. city of Swift Current, 1987). There is no doubt that the lake possesses considerable recreational potential which is not yet tapped (Hilderman Crosby Witty Hanna and Associates, 1984). The province is developing opportunities where a demand clearly exists (e.g. Elbow Harbour) but considerable potential remains. Whether such opportunities should be developed remains an issue.

In addition to the broad, basin-wide type of issues which are more acute in this subregion because of the presence of Lake Diefenbaker, this subregion also has some issues related to unique development proposals.

Waterfowl

Galloway Bay located at the upstream end of Lake Diefenbaker is a significant waterfowl staging area in the basin. At present, there are a number of different interests in this low lying shoreline area. Local farmers (Lacadena Conservation Area Authority, August 18, 1987) would like the area diked so that it could be farmed. However, the area has been designated under the Provincial Heritage Marsh Program. Ducks Unlimited intends to dike the area, thereby stabilizing water levels and improving the waterfowl habitat potential of the area.

Lake Diefenbaker presents some unique transportation issues in the subregion. At present, there is only one location for crossing the lake, the Riverhurst Ferry crossing. This ferry operates during the open water period and is replaced by an ice road during the winter when conditions permit. This transportation system works fairly well but there are periods when the system does not operate (i.e. spring break-up, winter freeze-up and extremely mild winters). During these periods, travellers must drive around the lake, which can increase travel distances and times substantially. In order to eliminate these difficulties, a local farmer has proposed that the ferry service be maintained throughout the year by installing a bubbler system to maintain an open channel. Mr. Sheppard (1986) has petitioned a number of government departments with this proposal. To date, the response has been negative, primarily because of the high cost of operating the bubbler system and its uncertain performance.

Transportation

The commercial fishery at Lake Diefenbaker has generated a modest opportunity in this subregion in some years and it may have additional potential. The sport fishery is considered by the provincial fisheries managers to be under utilized.

Fisheries

2.2.5 Issues in Subregion 5

Subregion 5 includes the portion of the basin extending from the Alberta-Saskatchewan boundary to Range 19 or approximately the upstream end of Lake Diefenbaker (Figure 4). In general, the water resources of this subregion are not intensively used and, as a result, issues are not common. Issues that do occur are mostly related to low flows.

This reach of the river is upstream of Lake Diefenbaker, and therefore, dependent upon Alberta for maintaining river flow. The flows are protected by the Master Agreement on Apportionment. Difficulties arise for some users during the summer months when flows drop near the minimum 42.5 m^3/s. For example, load restrictions have been imposed on the Estuary Ferry and irrigators have had difficulties with intakes (Technical Report E.7).

Summer Low Flows

In order to overcome these difficulties and encourage regional development, the Leader and District Economic Development Committee has proposed the development of a weir and provincial park. The proposed Fort Chesterfield Provincial Park would be centred around a weir constructed across the river near Chesterfield Flats. According to the proponents, the resulting impoundment would provide recreational opportunities, improved irrigation, improved water levels for the Town of Leader's municipal intake, and deeper water for the Estuary Ferry. This proposal is perceived by its local proponents to represent an opportunity for water to be used to encourage regional development. Because of the size of the river and the potential for very large flows, such a weir would be very expensive to construct.

Regional Development

2.2.6 Issues in Subregion 6

Subregion 6 is defined by the boundaries of the Swift Current Creek sub-basin (Figure 4). The water resources of this subregion are the most intensively used in the entire basin. Irrigation is the largest consumptive user of water with municipal and industrial users accounting for a significantly smaller amount of water (SSRBS Technical Report E.2). As a result of highly mineralized ground water discharge and agricultural runoff, water quality is an issue in this subregion.

The demand for water exceeds the supply in this subregion. Irrigation which began around the turn of the century has reached the point where the limits of the local supply have prevented any significant increases in use in recent years. In dry years, some users are not able to obtain their full allocation. Some groups in the subregion believe that the water resources of the subregion may be over-allocated (Herbert Water Users Association, 1987; city of Swift Current, 1987).

Irrigation

The city of Swift Current is of the opinion that the Duncairn Reservoir may not be capable of meeting their municipal demands for much longer and they would ultimately be looking to Lake Diefenbaker as a source of municipal water (city of Swift Current, 1987). The costs of such a project would be high and would have to be evaluated against the benefits which would include improved water supply, not only for the City but for agriculture as well. Water quality would also be improved.

Municipal Water Supply

In response to the water shortages in the subregion, Prairie Farm Rehabilitation Administration (PFRA) is studying options to improve the supply through local storage or diversion into the sub-basin. These options are long-term in that they require planning and development of large scale projects. In the mean time, short-term management strategies such as rationing can permit the existing developments to operate in low runoff years.

Although the city of Swift Current is not located immediately adjacent to Lake Diefenbaker, it is nonetheless concerned that the lake achieve its full recreational potential (city of Swift Current, 1987). The community believes that because it is the only large urban centre located near the west end of the lake, it will receive considerable spin-off benefits from the associated development.

Recreation

Within the Swift Current Creek basin there are two fairly large water-based recreation areas at Duncairn Reservoir and at Lac Pelletier. These are both multi-purpose reservoirs which also serve as water supplies. The optimum recreation use would require stable levels while the water supply uses require fluctuating levels to carry water from wet periods to the period when the water is needed. The issue of balancing the competing uses of the projects will require continuing management.

2.3 ISSUES UPSTREAM OF THE STUDY AREA

Most of the water in the South Saskatchewan River arises in the mountains and foothills in southwest Alberta. After flowing across the prairie area of southern Alberta and serving irrigation, municipal, industrial, recreation and other uses, the water arrives in Saskatchewan in the South Saskatchewan River and Red Deer River. The natural runoff and Alberta uses of the resource combine to determine the quantity and quality of the resource available for management in Saskatchewan. Therefore issues in the area upstream of the study area in Alberta are of concern to the basin study in Saskatchewan.

Master Agreement on Apportionment

The Master Agreement on Apportionment stipulates the minimum amount of water which Alberta must pass to Saskatchewan. As discussed in section 2.1.3, the apportionment formula has been taken as the upper limit of potential development in Alberta of the study. The Prairie Provinces Water Board which administers the interprovincial sharing of water in this river on behalf of the Prairie Provinces and Federal Government also monitors the water quality at the interprovincial boundary and is currently developing water quality objectives for the water at the boundary.

Alberta Water Uses

Concerns have been expressed that increasing industrial, municipal and irrigation development in Alberta would reduce the quality and quantity of water flowing into Saskatchewan (Chesterfield Water Users Association, 1987; Wild Goose Conservation Area Authority, 1987; Swift Current Creek Wildlife Federation, 1987). The Water Quality Technical Committee identified possible water quality problems relating to nutrients, toxins, salinity and organic pesticides. The Lower Saskatchewan Basin Task Force (1979), indicated that declining inflows would have a negative impact on hydro-electric power production, recreation and irrigation in Saskatchewan. In addition to the current development in the basin, these concerns relate to continued expansions to the water use infrastructure in Alberta. The Oldman River Dam, presently under construction with completion scheduled for the early 1990s, will allow Alberta to regulate flows more closely and hence increase water use and development within the basin. Other opportunities for development might come in the future.

In summary, future development in Alberta is capable of influencing the quality and quantity of water flowing into Saskatchewan. Planning efforts here must take into account the wide variation in the possible development in the upstream portions of the basin.

There are many management strategies which the province of Saskatchewan can implement to deal with the issues arising upstream in Alberta. In fact, the South Saskatchewan River Basin Study represents an important first step in dealing with these issues. There are limitations as to how effective strategies implemented only by Saskatchewan will be. Effective resolution of these issues will require considerable interprovincial co-operation. Fortunately, there is a proven forum for such co-operation: the Prairie Provinces Water Board.

2.4 ISSUES DOWNSTREAM OF THE STUDY AREA

The study area ends at the confluence of the South Saskatchewan and the North Saskatchewan Rivers. The Saskatchewan River (Figure 4) which begins at the confluence, flows for another 342 km before reaching the Manitoba boundary. There are several water resource management issues in this reach and further downstream which are influenced by actions taken in the study area.

Hydro-electric Energy Generation

SaskPower operates two hydro-electric projects on the Saskatchewan River: Nipawin and E.B. Campbell. With no dams located on the North Saskatchewan, both of these projects depend to a large extent on the flow regulation offered by Lake Diefenbaker to generate power when it is most needed. In fact, operation of the three facilities is highly integrated and accounts for approximately 20 percent of SaskPower's total power production. It should be noted that, while these three hydro-electric facilities account for 20 percent of the total power, they are frequently used to meet peaking power requirements and as such represent significantly more than 20 percent of the value of SaskPower's total production. Any significant changes to the streamflow pattern of the South Saskatchewan River would have effects extending beyond the generating capacity of the Coteau Creek station to the two downstream facilities. Water resource managers are aware of these wide ranging implications that changes in the flow of the South Saskatchewan River can produce.

The Saskatchewan River delta region straddles the Manitoba/Saskatchewan border downstream of the Squaw Rapids Generating Station. This is a flat region that is quite sensitive to variations in flow and water levels. Changes in the flow have an impact on transportation, water supplies, fishing, trapping and guiding activities. Actions within the South Saskatchewan River Basin can impact on water conditions in the delta. Conditions in the delta represent an issue with both short- and long-term implications.

Saskatchewan River Delta

At the Saskatchewan/Manitoba boundary, both streamflow and water quality are monitored to ensure that Saskatchewan meets its commitment to Manitoba under the Master Agreement on Apportionment. The Agreement does not stipulate how Manitoba's share must be met. Saskatchewan can meet its commitment to Manitoba from any combination of the flow of the South Saskatchewan and North Saskatchewan rivers. Any development scenario which includes the consumption of more than one half the natural flow in the South Saskatchewan River has implications for the management of the water resources in the North Saskatchewan River Basin. Therefore, this basin study must address the issue of how Saskatchewan will meet its commitment to Manitoba.

Commitments to Manitoba

2.5 ISSUES IN NEIGHBOURING BASINS IN SASKATCHEWAN

Southern Saskatchewan is a relatively dry area. The only large rivers are the North and South Saskatchewan Rivers. Over the years various proposals have been made to change the water supply of parts of the region by diverting water from one drainage basin to another. Diversions out of the South Saskatchewan River to the water short areas in the south and east have been proposed and diversions into the South Saskatchewan River from the North Saskatchewan River have been proposed. In order to permit the completion of the South Saskatchewan River Basin Study within a reasonable time frame and budget, it was necessary to limit the geographical boundaries of the study to the basin boundaries. It is therefore beyond the scope of this study to consider these potential diversions into or out of the basin in detail. The concern to the basin study is the impact of water management actions on this basin. Therefore the issue of inter-basin diversions is essentially the same as any other strategy that might augment or diminish the flow.

At present there are several inter-basin diversions in operation. Water can be released from Lake Diefenbaker at the Qu'Appelle Dam to meet water needs in the Qu'Appelle River Basin. This diversion has averaged about 80 000 dam³ per year. The SSEWS system carries water out of the basin into the north end of the Qu'Appelle River Basin. This diversion has averaged about 23 000 dam³ per year. The Rush Lake diversion carries about 6 000 dam³ per year from the Swift Current Creek sub-basin into the Old Wives Lake Basin. In total an average of about 110 000 dam³ per year or about two percent of the total flow is diverted out of the South Saskatchewan River Basin for a variety of uses in neighbouring basins.

Interbasin Diversion

Since there are no current proposals to divert significantly more water, from or to the basin, this is not a significant issue. If some proposal were to arise in the future it is important that the study develop the information on the importance of the water within the basin so that it can be compared to the value outside the basin so that a rational decision can be determined.

3.0 SUMMARY

The water and related land resources of the South Saskatchewan River Basin are vitally important to the Province of Saskatchewan. They are also intensively used by a wide variety of users. While these uses are generally compatible, a number of issues surrounding the use and management of these resources exist. This report documents the many current and emerging issues in the basin.

The issues in the basin are diverse. They include large issues with widespread implications, such as the operation of Gardiner Dam and Lake Diefenbaker, which require careful consideration of a wide range of users. The issues also include smaller site specific matters, such as difficulties with a particular municipal intake, which can be dealt with more easily.

Many of the issues in the basin are the result of an incomplete understanding of the complexity of water resource management by the people of the basin. The resolution of these issues may not require changes in the way the resource is managed, as much as, it may require a concerted effort to educate the public. Nevertheless, these perception issues should be analyzed and strategies proposed for their resolution.

Although it is clear that the water resources of the basin are well managed, the issues represent a challenge to managers. The issues represent an opportunity to more effectively manage the resource and generate greater benefits to a wider range of users than is currently the case. The South Saskatchewan River Basin Study represents an attempt by the agencies with water resource management responsibilities in the basin to do just this.

4.0 REFERENCES

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APPENDIX A

SOUTH SASKATCHEWAN RIVER BASIN STUDY
LIST OF TECHNICIAL REPORTS

SOUTH SASKATCHEWAN RIVER BASIN STUDY TECHNICAL REPORTS		
TITLE	SSRB TECHNICAL REPORT	DATE
Annual Report to December 31, 1986	A.3	11.87
Annual Report to December 31, 1987	A.4	07.88
Annual Report to December 31, 1988	A.5	05.89
Annual Report to December 31, 1989	A.6	03.90
Compendium of Water Quality Objectives Development Methodologies	D.9	06.88
Contaminant Organic Compounds in the Surface Waters of the South Saskatchewan River Basin	D.4	12.87
Crop Damage and Associated Economic Impact of Flooding, South Saskatchewan River Downstream of Lake Diefenbaker	E.13	12.89
Data Collection and Date Base Development: South Saskatchewan River Basin Recreation Survey	E.1	11.86
The Delphi Report	B.3	08.90
Demand for Water-Based Recreation in the South Saskatchewan River Basin	E.17	08.90
Economic Profile and Trends 1951-1986	E.9	06.88
Erosion and Sedimentation in the South Saskatchewan River Basin	C.9	12.89
Farm-Level Drought Analysis Model	E.15	08.90
Fishery Survey of the South Saskatchewan River and Its Tributaries in Saskatchewan	D.8	11.88
Flood Frequencies in the South Saskatchewan River Basin	C.5	08.88
Flooding Gardiner Dam to the Forks	C.8	10.89
Framework Plan Working Definition	B.1	09.87
Frequency Analysis of Meterological Drought in the Saskatchewan Portion of the South Saskatchewan River Basin	C.4	07.88
Ground Water and the South Saskatchewan River Basin: Recommendations to the Study Board	C.2	03.88
Ground Water Study: South Saskatchewan River Basin	C.2	03.88
Heritage Resources	E.16	08.90
A Hydraulic Study of the South Saskatchewan River	E.12	05.89
Hydro System Simulation (HYDSIM) Model Study Report	C.7	05.89
Hydrologic Drought Analysis of Simulated Flows - South Saskatchewan River Basin	C.6	02.89
Information Base: Surface Water Hydrology and Water Use	E.2	03.87
Instream Water Use: South Saskatchewan River Basin	E.7	12.87
Irrigation Water Use Pilot Study	E.8	04.88
Irrigation Water Use Survey (South Saskatchewan River Basin Study)	E.11	12.88
Lake Diefenbaker Trophic State Model	D.5	01.88
Land Use in the Effective Drainage Area of the South Saskatchewan River Basin	D.2	10.87

SOUTH SASKATCHEWAN RIVER BASIN STUDY TECHNICAL REPORTS		
TITLE	SSRB TECHNICAL REPORT	DATE
Legal and Administrative Analysis Interim Report	B.2	03.88
Legal and Administrative Summary	B.4	02.91
Low Flow Frequency Analysis for the South Saskatchewan River	C.10	05.91
Major Industrial Water Users in the South Saskatchewan River Basin	E.10	10.88
Mass Loading of Phosphorus to Lake Diefenbaker	D.13	09.89
Municipal and Residential Water Use Study	E.5	08.87
Municipal Water Use Survey	E.3	07.87
Nutrient Quality Review and Objectives Development for the South Saskatchewan River Basin	D.14	01.90
Phosphorus Loading from Non-Point Sources Relevant to the Lake Diefenbaker Basin	D.1	09.87
Proposed Water Quality Objectives for the South Saskatchewan River Basin	D.12	08.89
Public Involvement Program Position Paper	F.1	10.86
Public Opinion Survey, 1988 Survey Design	F.2	03.88
Recreational Data Analysis Report South Saskatchewan River Basin	E.4	07.87
Reservoir Salinity Model: Application to the Saskatoon Southeast Water Supply System	D.16	05.90
Reservoir Salinity Study Phase 1	D.7	10.88
Short-term Water Use Forecast South Saskatchewan River Basin Study	E.14	12.89
Study Plan and Annual Work Plans - 1987	A.2	02.87
Study Proposal for the South Saskatchewan River Basin	A.1	04.86
Style Guides for Reports	A.7	03.90
Summary and Evaluation of the Public Information and Awareness Strategy	F.3	09.89
Summary and Evaluation of the Public Information and Awareness Strategy, April 1990	F.4	04.90
Summary and Evaluation of the Public Information and Awareness Strategy, November 1990	F.5	12.90
Water Demand Management: An Application to the South Saskatchewan River Basin	E.18	08.90
Water Intake and Outfall Survey South Saskatchewan River Basin	E.6	12.87
Water Management Model Study South Saskatchewan River Basin	C.1	01.88
Water Quality Data Review	D.6	03.88
Water Quality Modelling South Saskatchewan River	D.10	04.89
Water Quality Monitoring Plan for the South Saskatchewan River Basin	D.15	04.90
Water Quality Monitoring Review South Saskatchewan River Basin	D.11	06.89
Water Quality Trend Analysis and Data Base Summary	D.3	11.87
Water Use Analysis Model Study: South Saskatchewan River Basin Study	D.19	05.91

APPENDIX B
MASTER AGREEMENT ON APPORTIONMENT

MASTER AGREEMENT ON APPORTIONMENT

THIS AGREEMENT is made in quadruplicate this THIRTIETH day of OCTOBER, 1969, A.D.

BETWEEN:

HER Majesty, the Queen, in right of Canada, represented herein by the Minister of Energy, Mines and Resources

(Hereinafter called "Canada")

- and -

HER Majesty, the Queen, in right of Alberta, represented herein by the Minister in charge of Water Resources for Alberta

(Hereinafter called "Alberta")

- and -

HER Majesty, the Queen, in right of Saskatchewan, represented herein by the Minister in charge of The Water Resources Commission Act of the said Province

(Hereinafter called "Saskatchewan")

- and -

HER Majesty, the Queen, in right of Manitoba, represented herein by the Minister in charge of The Water Control and Conservation Branch Act of the said Province

(Hereinafter called "Manitoba")

WHEREAS under natural conditions the waters of the watercourses hereinafter referred to arising in or flowing through the Province of Alberta would flow into the Province of Saskatchewan and under the said conditions the waters of some of the said watercourses arising in or flowing through the Province of Saskatchewan would flow into the Province of Manitoba;

AND WHEREAS the Governor-in-Council has authorized Canada to enter into this agreement by Order-in-Council P.C. 1969-8/2051 dated October 29, 1969, and the Lieutenant Governors-in-Council for Alberta, Manitoba and Saskatchewan, respectively, have authorized them to enter into this agreement by the following Orders-in-Council:

Alberta	- O.C. 2053-69
Manitoba	- O.C. 1359/69
Saskatchewan	- O.C. 1612/69

AND WHEREAS the parties hereto deem it to be in their mutual interest that an agreement be reached among the four parties as to the apportionment as described in the schedules attached hereto of such interprovincial waters among the three Provinces;

AND WHEREAS Alberta and Saskatchewan have entered into an agreement, which agreement is attached to this agreement as Schedule A, that permits the Province of Alberta to make a net depletion of one-half the natural flow of water arising in or flowing through the Province of Alberta and that permits the remaining one-half of the natural flow of each such watercourse to flow into the Province of Saskatchewan, subject to certain exceptions as are set forth in the said agreement;

AND WHEREAS Saskatchewan and Manitoba have entered into an agreement which agreement is attached to this agreement as Schedule B, that permits the Province of Saskatchewan to make a net depletion of one-half the natural flow of water arising in, and one-half of the water flowing into the Province of Saskatchewan, and that permits the remaining one-half of the flow of each such watercourse to flow into the Province of Manitoba, subject to such conditions and agreements as therein contained;

AND WHEREAS the parties are desirous that the Prairie Provinces Water Board (referred to herein as the Board), reconstituted by this agreement will be responsible for the administration of this agreement;

AND WHEREAS the parties hereto recognize the continuing need for consultation and co-operation as between themselves with respect to the matters herein referred to so that the interests of all the parties are best served;

NOW THEREFORE, THIS AGREEMENT (hereinafter known as the Master Agreement) witnesseth that each party agrees as follows:

Interprovincial Agreements

1. Alberta and Saskatchewan agree that the agreement between them (hereinafter called the First Agreement), a copy of which is set out in Schedule A to the Master Agreement, will become binding upon them upon the date that the Master Agreement is executed.

2. Saskatchewan and Manitoba agree that the agreement between them (Hereinafter called the Second Agreement), a copy of which is set out in Schedule B to the Master Agreement, will become binding upon them upon the data that the Master Agreement is executed.

3. The parties agree to the apportionment of water between Alberta and Saskatchewan and Manitoba as provided in the First and Second Agreements and each party agrees to be bound by the said agreements as they relate to apportionment as if it were a party thereto.

4. The parties agree that the First or Second Agreement, or both, may be altered by an agreement in writing among the four parties to the Master Agreement, but not otherwise.

5. The parties agree that the First and Second Agreements will continue in force and effect until cancelled by an agreement in writing among the four parties to the Master Agreement.

Water Quality

6. The parties mutually agree to consider water quality problems; to refer such problems to the Board; and to consider recommendations of the Board thereon.

Monitoring

7. The parties agree that the monitoring of the quantity and quality of waters as specified in the First and Second Agreements, the collection, compilation and publication of water quantity and quality data required for the implementation and maintenance of the provisions of this agreement shall be conducted by Canada, subject to provision of funds being voted by the Parliament of Canada.

Administration

8. The parties agree, subject to Clause 9 of this agreement that it at any time, any dispute, difference or question arises between the parties with respect to this agreement or the construction, meaning and effect thereof, or anything therein, or the rights and liabilities of the parties thereunder or otherwise in respect thereto, then every such dispute, difference or question will be referred for determination to the Exchequer Court under the provisions of the Exchequer Court Act of Canada and each of the parties hereto agrees to maintain or enact the necessary legislation to provide the Exchequer Court with jurisdiction to determine any such dispute, difference, or question in the manner provided under the Exchequer Court Act.

9. The parties also agree that the Board, with the consent of the parties in dispute, may cause to be prepared, a factual report of the dispute for consideration by the parties hereto prior to the referral of the dispute to the Exchequer Court.

10. The parties agree that the Prairie Provinces Water Board shall monitor and report on the apportionment of waters as set out in the provisions of the First and Second Agreements and ratified by this Master Agreement.

11. The parties agree to revoke the agreement data July 28, 1948, establishing the Prairie Provinces Water Board and to reconstitute the Prairie Provinces Water Board in the form of Schedule C hereto and the said Schedule shall form and become part of this Master Agreement.

12. Because the Orders-in-Council referred to in Schedule D hereto will become redundant upon the execution of this Master Agreement, the parties agree to take steps to have them revoked.

13. The parties agree for the future application of the provisions of the Master Agreement (and the First and Second Agreements thereunder), to work together and to cooperate to the fullest extent each with the other for the integrated development and use of water and related resources to support economic growth according to selected social goals and priorities and to participate in the formulation and implementation of comprehensive planning and development programs according to their national, regional and provincial interest and importance.

14. No Member of the Parliament of Canada or Member of the Legislative Assemblies of the Provinces party to this agreement shall hold, enjoy, or be admitted to any share or part of any contract, agreement, commission or benefit arising out of this agreement.

IN WITNESS HEREOF Canada has caused its presents to be executed by its Minister of Energy, Mines and Resources, and Alberta has caused its presents to be executed by its Minister in charge of Water Resources, and Saskatchewan has caused its presents to be executed by its Minister in charge of The Water Resources Commission Act, and Manitoba has caused its presents to be executed by its Minister in charge of The Water Control and Conservation Branch Act of the day and year first mentioned above.

"A. Davidson"
Witness to the signature of the Minister
(Energy, Mines and Resources) for Canada

"J.J. Greene"
Minister (Energy, Mines and Resources) for Canada

October 30, 1969
Date

"R.E. Bailey"
Witness to the signature of the Minister in
charge of Water Resources for Alberta

"Henry A. Ruste"
Minister in charge of Water Resources for
Alberta

October 30, 1969
Date

"Harold W. Pope"
Witness to the signature of the Minister
in charge of The Water Resources Commission
Act for Saskatchewan

"Allan R. Guy"
Minister in charge of The Water Resources
Commission Act for Saskatchewan

October 30, 1969
Date

"Thomas E. Weber"
Witness to the signature of the Minister in
charge of The Water Control and Conservation Branch Act
for Manitoba

"Leonard S. Evans"
Minister in charge of The Water Control
and Conservation Branch Act for Manitoba

October 30, 1969
Date

4th Recital Clause amended on July 5, 1984

SCHEDULE A

THIS AGREEMENT is made in quadruplicate this THIRTIETH day of OCTOBER, 1969, A.D.

BETWEEN:

HER Majesty, the Queen, in right of Alberta, represented herein by the Minister in charge of Water Resources for Alberta

(Hereinafter called "Alberta")

- and -

HER Majesty, the Queen, in right of Saskatchewan, represented herein by the Minister in charge of The Water Resources Commission Act of the said Province

(Hereinafter called "Saskatchewan")

WHEREAS under natural conditions the waters of the watercourses hereinafter referred to arising in or flowing through the Province of Alberta would flow into the Province of Saskatchewan and under the said conditions the waters of some of the said watercourses arising in or flowing through the Province of Saskatchewan would flow into the Province of Manitoba;

AND WHEREAS the parties hereto deem it to be in their mutual interest and in the interest of Manitoba that an agreement in principle be reached among the said three Provinces as to the apportionment of such interprovincial waters among them;

AND WHEREAS the parties hereto are of the opinion that an equitable apportionment of such waters as between the adjoining Provinces of Alberta and Saskatchewan would be to permit the Province of Alberta to make a net depletion of one-half the natural flow of water arising in or flowing through the Province of Alberta and to permit the remaining one-half of the natural flow of water of each such watercourse to flow into the Province of Saskatchewan, subject to certain prior rights as are hereinafter set forth or may hereafter be mutually agreed upon in writing;

AND WHEREAS on the basis of the foregoing apportionment as between the Provinces of Alberta and Saskatchewan the parties hereto are of the opinion that in a similar manner, an equitable apportionment of the remainder of the natural flow of the said watercourses that flow into the Province of Manitoba after permitting the Province of Alberta to make its depletion of one-half thereof would be to permit the Province of Saskatchewan to make a net depletion of one-half of the said remainder and to permit the other one-half thereof to flow into the Province of Manitoba; and that the natural flow of any tributaries to the said watercourses which tributaries join the said watercourses in the Province of Saskatchewan without arising in or first flowing through the Province of Alberta could be apportioned one-half to the Province of Saskatchewan and one-half to the Province of Manitoba in a manner similar to the apportionment of waters as between the Provinces of Alberta and Saskatchewan, in all cases subject to such prior rights as may be mutually acknowledged by the said Provinces of Manitoba and Saskatchewan;

AND WHEREAS the parties hereto recognize the continuing need for consultation and cooperation as between themselves and with Manitoba with respect to the matters herein referred to so that the best and most beneficial use of the said waters may be made and the interests of all said provinces best served:

NOW THIS AGREEMENT witnesseth as follows:

1. IN THIS AGREEMENT:

(a) "Natural flow" means the quantity of water which would naturally flow in any watercourse had the flow not been affected by human interference or human intervention, excluding any water which is part of the natural flow in Alberta but is not available for the use of Alberta because of the provisions of any international treaty which is binding on Alberta.

(b) "Watercourse" means any river, stream, creek, or other natural channel which from time to time carries a flowing body of water from the Province of Alberta to the Province of Saskatchewan and includes all tributaries of each such river, stream, creek or natural channel which do not themselves cross the common boundary between the Provinces of Alberta and Saskatchewan. Such tributaries as do themselves cross the said common boundary

between the Provinces of Alberta and Saskatchewan shall be deemed to be "watercourses" for the purpose of this agreement.

2. (a) The parties hereto shall mutually establish a method by which to determine the natural flow of each watercourse flowing across their said common boundary.

(b) For the purpose of this agreement, the said natural flow shall be determined at a point as near as reasonably may be to their said common boundary.

(c) Notwithstanding sub-paragraph (b) the point of which the natural flow of the watercourses known as the South Saskatchewan and Red Deer Rivers is to be determined may be, at the option of Alberta, a point at or as near as reasonably may be below the confluence of the said two rivers.

3. Alberta shall permit a quantity of water equal to one-half the natural flow of each watercourse to flow into the Province of Saskatchewan, and the actual flow shall be adjusted from time to time on an equitable basis during each calendar year, but this shall not restrict or prohibit Albert from diverting or consuming any quantity of water from any watercourse provided that Alberta diverts water to which it is entitled of comparable quality from other streams or rivers into such watercourse to meet its commitments to Saskatchewan with respect to each watercourse.

4. Notwithstanding paragraph 3 hereof, the following special provisions shall apply as between the parties hereto with respect to the watercourse known as the South Saskatchewan River.

(a) Alberta shall be entitled in each year to consume, or to divert or store for its consumptive use a minimum of 2 100 000 acre-feet net depletion out of the flow of the watercourse known as the South Saskatchewan River even though its share for the said year, as calculated under paragraph 3 hereof, would be less than 2 100 000 acre-feet net depletion, provided however Alberta shall not be entitled to so consume or divert, or store for its consumptive use, more than one-half the natural flow of the said South Saskatchewan watercourse if the effect thereof at any time would be to reduce the actual flow of the said watercourse at the common boundary of the said Provinces of Saskatchewan and Alberta to less than 1,500 cubic feet per second.

(b) The consumption or diversion by Alberta provided for under the preceding sub-paragraph shall be made equitably during each year, depending on the actual flow of water in the said watercourse and the requirements of each Province, from time to time.

5. The parties hereto shall work together and co-operate to the fullest extent, each with the other, for the most effective, economical and beneficial use of waters flowing from the Province of Alberta into the Province of Saskatchewan, including the construction and operation of approved projects of mutual advantage to our Provinces on a cost-share basis proportionate to the benefits derived therefrom by each Province, (the approval of which projects shall not be unreasonably withheld by either of the parties hereto) and shall enter into such other arrangements, agreements or accords with each other, and with the Governments of Canada and other Provinces to best achieve the principles herein agreed upon.

6. Notwithstanding paragraph 3 hereof, with respect to each of the three watercourses known as Battle Creek, Lodge Creek, and Middle Creek, the annual flow shall be apportioned such that, in each of the said watercourses, Alberta permits a quantity of water equal to 75 percent of the natural flow to pass the interprovincial boundary from Alberta to Saskatchewan.

7. If at any time any dispute, difference or question shall arise between the parties or their representatives touching this agreement or the construction, meaning and effect thereof, or anything therein, or the rights or liabilities, of the parties or their representatives thereunder or otherwise in respect thereto then every such dispute, difference or question shall be referred for determination to the Exchequer Court under the provisions of The Exchequer Court Act of Canada, and each of the parties hereto agrees to enact the necessary legislation to provide the Exchequer Court with jurisdiction to determine any such dispute, difference or question in the manner provided under Section 30 of The Exchequer Court Act.

8. This agreement shall become effective upon the execution of an agreement by Canada, Alberta, Manitoba and Saskatchewan relative to the apportionment of waters referred to in this agreement.

IN WITNESS WHEREOF Alberta has caused these presents to be executed on its behalf by its Minister in charge of Water Resources, and Saskatchewan has caused these presents to be executed by its Minister in charge of The Water Resources Commission Act, both on the day and year first above mentioned.

"R.E. Bailey"
Witness to the signature of the Minister
in charge of Water Resources for Alberta

"Henry A. Ruste"
Minister in charge of Water Resources for Alberta

"Harold W. Pope"
Witness to the signature of the Minister
in charge of The Water Resources Commission Act

"Allan R. Guy"
Minister in charge of The Water Resources Commission Act

Section 6 amended on July 5, 1984.

SCHEDULE B

THIS AGREEMENT is made in quadruplicate this THIRTIETH day of October, 1969, A.D.

BETWEEN:

HER Majesty, the Queen, in right of Saskatchewan, represented herein by the Minister in charge of The Water Resources Commission Act of the said Province

(Hereinafter called "Saskatchewan)

- and -

HER Majesty, the Queen, in right of Manitoba, represented herein by the Minister in charge of The Water Control and Conservation Branch Act of the said Province

(Hereinafter called "Manitoba")

WHEREAS under natural conditions the waters of the watercourses hereinafter referred to arising in or flowing through the Province of Saskatchewan would flow into the Province of Manitoba;

AND WHEREAS the parties hereto deem it to be in their mutual interest and in the interest of Alberta that an agreement in principle be reached among the said three Provinces as to the apportionment of interprovincial waters among them;

AND WHEREAS the parties hereto are of the opinion that an equitable apportionment of such waters as between the adjoining Provinces of Saskatchewan and Manitoba would be to permit the Province of Saskatchewan to make a net depletion of one-half the natural flow of water arising in, and one-half the flow of water flowing into, the Province of Saskatchewan, and to permit the remaining one-half of the flow of water of each such watercourse to flow into the Province of Manitoba, subject to certain rights as may hereafter be mutually agreed upon in writing;

AND WHEREAS on the basis of the forgoing apportionment as between the Provinces of Saskatchewan and Manitoba, the parties hereto are of the opinion that in a similar manner, an equitable apportionment of the natural flow of the said watercourses arising in or flowing through the Province of Alberta would be to permit the Province of Alberta to make a net depletion of one-half thereof, subject to such prior rights as may be mutually acknowledged by the said Provinces of Alberta, Saskatchewan and Manitoba;

AND WHEREAS the parties hereto recognize the continuing need for consultation and co-operation as between themselves and with Alberta with respect to the matters herein referred to so that the interests of all said Provinces are best served;

NOW THIS AGREEMENT witnesseth as follows:

1. IN THIS AGREEMENT:

   (a) "Natural flow' means the quantity of water which would naturally flow in any watercourse had the flow not been affected by human interference or human intervention.

   (b) "Watercourse" means any river, stream, creek, o r other natural channel which from time to time carries a flowing body of water from the Province of Saskatchewan to the Province of Manitoba and includes all tributaries of each such river, stream, creek or natural channel which do not themselves cross the common boundary between the Provinces of Saskatchewan and Manitoba. Such tributaries as do themselves cross the said common boundary between the Provinces of Saskatchewan and Manitoba shall be deemed to be "watercourses" for the purpose of this agreement.

2. (a) The parties hereto shall mutually establish a method by which to determine the natural flow of each watercourse flowing across their said common boundary.

   (b) For the purpose of this agreement, the said natural flow shall be determined at a point as near as reasonably may be to their said common boundary.

3. Saskatchewan shall permit in each watercourse the following quantity of water to flow into Manitoba during the period from April 1 of ezch year to march 31 of the year following: A quantity of water equal to the natural flow for that period determined at the point referred to in paragraph 2(b) hereof, less

   (a) one-half the water flowing into Saskatchewan in that watercourse from Alberta, and

   (b) any water which would form part of the natural flow in that watercourse but does not flow into Saskatchewan because of the implementation of any provision of any subsisting water apportionment agreement made between Alberta and Saskatchewan and approved by Manitoba, and

   (c) one-half the natural flow arising in Saskatchewan.

   The actual flow shall be adjusted from time to time by mutual agreement on an equitable basis during such period but this shall not restrict or prohibit Saskatchewan from diverting, storing or consuming any quantity of water from any watercourse provided that Saskatchewan diverts water to which it is entitled of comparable quality from other streams or rivers into such watercourse to meet its commitments to Manitoba with respect to each watercourse.

4. Saskatchewan shall be entitled during such period to consume or to divert or store for its consumptive use the water it is not required to permit to flow into Manitoba in each watercourse under paragraph 3 hereof, but such consumption or diversion shall be made equitably depending on the actual flow of water in each watercourse and the requirements of each Province from time to time, but Saskatchewan shall permit sufficient water to flow into Manitoba to meet its commitments during such period under paragraph 3 hereof.

5. The parties hereto shall work together and co-operate to the fullest extent, each with the other, for the use of waters flowing from the Province of Saskatchewan into the Province of Manitoba, including the construction and operation of approved projects of mutual advantage to the said Provinces on a cost-share basis proportionate to the benefits derived therefrom by each Province (the approval of which projects shall not be unreasonably withheld by either of the parties hereto) and shall enter into such other arrangements, agreements or accords with each other, and with the Governments of Canada and other Provinces to best achieve the principles herein agreed upon.

6. If at any time any dispute, difference or question shall arise between the parties or their representatives touching this agreement or the construction, meaning and effect thereof, or anything therein, or the rights or liabilities of the parties or their representatives thereunder or otherwise in respect thereto then every such dispute, difference or question shall be referred for determination to the Exchequer Court under the provisions of The Exchequer Court Act of Canada, and each of the parties hereto agrees to maintain or enact the necessary legislation to provide the Exchequer Court with jurisdiction to determine any such dispute, difference or question in the manner provided under The Exchequer Court Act.

7. This agreement shall become effective upon the execution of an agreement by Canada, Alberta, Manitoba and Saskatchewan relative to the apportionment of waters referred to in this agreement.

IN WITNESS WHEREOF Saskatchewan has caused these presents to be executed by its Minister in charge of The Water Resources Commission Act, and Manitoba has caused these presents to be executed by its Minister in charge of The Water Control and Conservation Branch Act on the day and year first above mentioned.

"Harold W. Pope"
Witness to the signature of the Minister
in charge of The Water Resources Commission Act

"Allan R. Guy"
Minister in charge of The Water Resources Commission Act

"Thomas E. Weber"
Witness to the signature of the Minister
in charge of The Water Control and Conservation Branch Act

"Leonard S. Evans"
Minister in charge of The Water Control and Conservation Branch Act.

SCHEDULE C

PRAIRIE PROVINCES WATER BOARD AGREEMENT

THIS AGREEMENT made this THIRTIETH day of OCTOBER, 1969, A.D.

BETWEEN:

THE GOVERNMENT OF CANADA, hereinafter called "Canada"

- and -

THE GOVERNMENT OF MANITOBA, hereinafter called "Manitoba"

- and -

THE GOVERNMENT OF SASKATCHEWAN, hereinafter called "Saskatchewan"

- and -

THE GOVERNMENT OF ALBERTA, hereinafter called "Alberta"

1. Manitoba, Saskatchewan, Alberta and Canada agree to establish and there is hereby established a Board to be known as the Prairie Provinces Water Board to consist of five members to be appointed as follows:

   (a) two members to be appointed by the Governor General in Council, one of whom shall be Chairman of the Board, on the recommendation of the Minister of Energy, Mines and Resources,

   (b) one member to be appointed by the Lieutenant Governor in Council of each of the Provinces of Manitoba, Saskatchewan and Alberta.

2. Functions

   The Board shall oversee and report on the Master Agreement (including the First and Second Agreements thereunder) executed by Canada, Alberta, Manitoba and Saskatchewan for the apportionment of waters flowing from one Province into another province; shall take under consideration, comprehensive planning, water quality management and other questions pertaining to water resource management referred to it by the parties hereto; shall recommend appropriate action to investigate such matters and shall submit recommendations for their resolution to the parties hereto.

3. Composition of Board

   The members of the Board shall be chosen from those engaged in the administration of water resources or related duties for Manitoba, Saskatchewan, Alberta or Canada, as the case may be, and shall serve as members of the Board in addition to their other duties.

4. Duties of the Board

   In accordance with its functions, the duties of the Board shall be as follows:

   (a) to review, collate, and analyze streamflow data and prepare reports and recommendations on the apportionment of water,

   (b) to review water quality problems, particularly such problems located at the interprovincial boundaries, and to recommend to the parties hereto, appropriate management approaches for their resolution including the establishment of new institutional arrangements,

   (c) to develop recommendations on other water matters, in addition to problems on water quality, referred to the Board by any party hereto including the review and analysis of existing information and the requesting of additional studies and assistance by appropriate governmental agencies to provide information for formulating its recommendations.

(d) to promote through consultation and the exchange of information the integrated development of water resources of interprovincial streams,

(e) to cause to be prepared with the consent of the parties involved factual reports on disputes arising out of the water apportionment for consideration by the parties hereto,

(f) to ensure the co-ordination of such technical programs as water quantity and quality monitoring and streamflow forecasting required for the effective apportionment of water.

5. Confirmation of the Board's Recommendations

A recommendation of the Board with respect to any matters referred to it under Section 2 shall, subject to the Master Agreement for the apportionment of water, become effective when adopted by Orders-in-Council passed by Canada and each of the Provinces.

6. Authority of Board

The Board shall have authority to correspond with all Governmental organizations and other sources of information in Canada or abroad concerned with the administration of water resources, and such other authority as may be conferred on the Board rom time to time by agreement between the parties hereto; all agencies of the four governments having to do with the water and associated resources in the area covered by the Agreement shall be required to supply the Board with all data in their possession requested by the Board.

7. Records

The records relating to the water resources of the three provinces collected and compiled by the P.F.R.A. organization at Regina shall be made available to the Board.

8. Meetings of the Board

The Board shall meet at the call of the Chairman and meetings shall be called at least twice annually; the expenses of the members shall be borne by their respective governments.

9. Reports

The Board shall submit an annual progress report outlining work done and work contemplated in the agreed program to each of the responsible Ministers of the parties hereto and such other reports as may be requested by any one of such Ministers.

10. Operation of the Board

The Secretary for the Board and such other technical and clerical staff as may be required, with a headquarters at Regina, shall be Federal or Provincial public servants. The cost of administration, excluding the cost of monitoring as described in Section 7 of the Master Agreement, but including staff, accommodation, supplies and incidental expenses of the Board, shall be borne by the parties hereto on the basis of one-half by Canada and one-sixth by each of the Provinces. The Board shall prepare for approval of the parties hereto, work program, staff requirements, annual budgets and five-year forecasts and such other reports as may be required in the operation of the Board.

11. Any water development project already constructed or to be constructed by any one of the parties shall be so operated as to maintain the apportionment of water as set out in the Master Agreement (and the First and Second Agreements thereunder) for the apportionment of waters of interprovincial streams.

SCHEDULE D

PREVIOUS ALLOCATIONS OF INTERPROVINCIAL WATERS APPROVED BY ORDERS-IN-COUNCIL BY THE GOVERNMENTS OF CANADA, ALBERTA, MANITOBA, AND SASKATCHEWAN

Item	Order-in-Council			
	Canada	Alberta	Saskatchewan	Manitoba
Allocation of water for specific projects in Alberta	4030/49	857/49	1307/51	1121/49
Allocation of water for specific projects in Saskatchewan	1874/51	1091/51	1310/51	1264/51
Allocation of water for South Saskatchewan River Project in Saskatchewan	973/53	991/53	1271/53	924/53